GOLDEN GATE BRIDGE
SEISMIC RETROFIT PROJECT
PHASE ONE, LEAD CLEANUP AND SITE PREPARATION
DRAFT
REMEDIAL ACTION PLAN

Submitted by:

GOLDEN GATE BRIDGE, HIGHWAY
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PETE WILSON, *Governor*

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November 1, 1995

Mr. Kary Witt, P.E., C.I.H.
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Golden Gate Bridge, Highway and Transportation District
P.O. Box 9000
San Francisco, California 94129

Dear Mr. Witt:

GOLDEN GATE BRIDGE SITE, PHASE I SEISMIC RETROFIT PROJECT REMEDIAL ACTION PLAN FOR THE REMOVAL ACTION

The Department of Toxic Substances Control (DTSC) has completed review of the Draft Remedial Action Plan (draft RAP) submitted August 31, 1995, as modified by the September 13, 1995 submittal. The draft RAP is approved for public comment. DTSC's Statement of Reasons is enclosed and must be inserted in draft RAP, Appendix A. A copy of the draft RAP must be sent to and received by each of the parties named in the NBAR prior to the start of the public comment period. The public comment period will run concurrent with the public comment period for the draft Environmental Assessment/Initial Study being reviewed by the Federal Highway Administration (FHWA). The public comment period, currently projected to begin in November 1995 and to finish in January 1996, is dependent upon finalization of the draft Environmental Assessment/Initial Study for public comment.

If you have any comments or questions, please contact Janet Naito at (510) 540-3833.

Sincerely,

Barbara J Cook

Barbara J. Cook, P.E., Chief
North Coast California Cleanup
Operations Branch

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Golden Gate Bridge,
Highway and
Golden Gate Bridge
seismic retrofit
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INTRODUCTION

Since 1937, the Golden Gate Bridge, Highway and Transportation District (GGBH&TD) has operated and maintained the Golden Gate Bridge (Bridge) across the entrance to San Francisco Bay. In accordance with a mandate by the Governor of the State of California, subsequent to the 1989 Loma Prieta earthquake, and in order to maintain the Bridge in a structurally sound condition, the GGBH&TD in 1992 began the planning for a seismic retrofit project to protect the structural integrity of the Bridge in the event of a major seismic incident. Primarily as a result of historic sandblasting of lead based paint connected with Bridge maintenance, areas underneath and adjacent to the Bridge have become contaminated with lead. Under the direction of the State of California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC"), the GGBH&TD have developed a comprehensive phased lead cleanup program for the Bridge. The phasing of the project is required to accommodate the strict scheduling and staging requirements of the Seismic Retrofit Project. Phase I addresses the lead-contaminated soils in the Seismic Retrofit Project areas beneath the north and south approaches to the Bridge to protect the construction workers involved in this project. Phase II will evaluate the extent of lead contamination outside of the Seismic Retrofit Project areas, assess ecological risk for the entire site, and evaluate what measures may be appropriate to address any excessive ecological or human health risk.

The following report presents the Remedial Action Plan (RAP) for a Removal Action (RA) in the Phase I areas of the Golden Gate Bridge Lead Cleanup Project.

1.1 PURPOSE OF THE REMEDIAL ACTION PLAN

The purpose of this RAP is to compile and summarize site data gathered from the site investigation and technology evaluations in order to identify, and subsequently design, plan, and implement a Removal Action in order to accommodate the Seismic Retrofit Project. The RAP approval process is the means by which the public is provided an opportunity to be involved in remedial action decision-making for hazardous substance release sites.

This RAP summarizes site investigation information presented in the May 1994 report *Results of Preliminary Vertical Delineation* (which represents the Remedial Investigation (RI) for this phase of the project) and technology testing results presented in the November 1993 *Pilot Test Results* and December 1993 *Field Demonstration* reports. This RAP also presents a human health risk assessment which, taken together with the two earlier technology testing results reports, represents the Feasibility Study (FS) for this phase of the project. This RAP further presents remedial action alternatives and also sets out specific remedial action objectives and time frames for completion of activities. The RAP is not intended to contain specific engineering design details of the proposed cleanup option; however, it describes the selected and rejected options to the extent that the interested public, other government agencies, and potentially responsible parties (PRPs) are given meaningful opportunity to provide DTSC with opinions and comments. This RAP has been prepared in accordance with Chapter 6.8, Section 25356.1 of the California Health and Safety Code and the DTSC guidance document "Remedial Action Plan Development and Approval Process," dated October 5, 1987.

This Remedial Action Plan (RAP) is for Phase I of the GGBH&TD Lead Cleanup Project. This phase provides for the removal of soil containing elevated concentrations of lead from areas within the Seismic Retrofit Project areas beneath the north and south approaches to the Bridge. The implementation of this RAP is intended to result in the reduction of human health risk to acceptable levels for construction workers involved in the Seismic Retrofit Project and subsequently for recreational and other public uses. Phase II of the Project will evaluate the extent of lead contamination outside of the Seismic Retrofit Project areas, assess ecological risk for the entire site, and evaluate what measures may be appropriate to address any excessive ecological or human health risk. The human health risk assessment performed under Phase I is intended to be applicable to the portions of the Phase II areas that are human accessible. Similarly, the ecological risk assessment performed under Phase II will be applicable to those portions of the Phase I areas that offer habitat for the species of concern. The final long-term remedy at the site will take into account the findings from both the Phase I and Phase II studies.

The phasing of this project is required to accommodate the strict scheduling and staging requirements of the Seismic Retrofit Project. This five year, 150 million dollar federally funded project is scheduled to begin construction in January 1995, and is essential to structurally strengthen the Golden Gate Bridge and ensure general public safety in the event of a major seismic occurrence. The remedial action presented in this RAP is part of the site preparation of the Seismic Retrofit Project, and must be completed prior to any excavation in the area to provide a safe working environment for construction workers.

The Phase I RAP objectives include:

- Select an alternative that, when implemented will immobilize or remove lead to the extent required to protect the health and safety of Seismic Retrofit Project workers and the general public who may subsequently use the site for recreational purposes.
- Expedite cleanup actions in areas known to contain high lead levels.
- Coordinate the remedial action with the Seismic Retrofit Project schedule.
- Minimize impact to the biological community during implementation by performing the remedial action consistent with the Biological Assessment (ESA 1994) prepared for the Seismic Retrofit Project.

1.2 SITE IDENTIFICATION

The site consists of two separate areas, the north and south approaches to the Golden Gate Bridge. The south approach is located at the Fort Point National Historic Site area within the Golden Gate National Recreation Area, on the Presidio in the city and county of San Francisco. The north approach is located at the Lime Point area at East Fort Baker, in the county of Marin. The site ownership was transferred from the Department of Defense (DOD) to the Department of the Interior (DOI) on October 1, 1994, and is under permit to Golden Gate Bridge Highway and Transportation District (GGBH&TD). The approach areas are used for bridge and highway access and maintenance and for tourism and recreation. The location of the site and its surroundings are shown in Figure 1-1.

The limits of the Phase I project area are defined by the Seismic Retrofit Project construction, staging, and access areas and the high tide line. Phase II will consider other areas beyond the Phase I area, including aquatic sediment sampling and step-out sampling on land to define the lateral extent of contamination.

1.3 SCOPE OF THE RAP

This Remedial Action Plan (RAP) includes a summary of the site investigations and the health risk evaluation conducted to date and it also evaluates different alternatives for cleanup of the Phase I areas and recommends one alternative.

The Phase I areas are based on the construction, staging, and access areas of the Seismic Retrofit Project, as well as other public use areas directly beneath and to either side of the Bridge's north and south approaches. Within these areas, the Phase I remedial action will remove soil containing lead above the risk based cleanup level. The human health risk assessment was performed to determine a cleanup level for the site that is protective of human health, considering the employment, tourism and recreational uses of the site. The general environmental setting information presented in this Phase I RAP is based upon reports prepared for the GGBH&TD Seismic Retrofit Project, including the Draft Biological Assessment and Administrative Draft Environmental Assessment. CEQA/NEPA documentation for the Seismic Retrofit Project encompasses this Phase I Lead Cleanup Project, and will be released for public comment concurrent with this draft RAP.

Phase II of the Lead Cleanup Project will include site characterization designed to step out from the Phase I areas to determine the lateral extent of contamination. Phase II will also include ecological risk assessment, to evaluate the impact of lead on the ecological aspects of the site area. The final, long-term remedy for the site is dependent on both Phase I and Phase II studies. There is a potential for Phase I areas to be further remediated based on future Phase II studies.

The site remedial investigation, human health risk assessment, feasibility study, and associated studies presented in this RAP show that a residual level of lead that is protective of human health will be achieved by implementing the selected measure. This RAP is organized as follows:

- Section 1.0 Introduction, provides an introduction to the site and the RAP, including the purpose and scope of the report.

- Section 2.0 Executive Summary, is the executive summary as outlined by the DTSC guidance document.

- Section 3.0 Detailed Description of Site Characteristics, describes the past and current property use, topography, demography, and other site characteristics.

- Section 4.0 Summary of Remedial Investigation Findings summarizes the site geology, hydrology, air quality and biologic community assessments based on remedial investigation findings and based on environmental documentation prepared for the Seismic Retrofit Project.

- Section 5.0 Health and Safety Risks summarizes the human health risk assessment which was prepared to determine a cleanup level for the site based on specific uses of the site.

- Section 6.0 Effects of Contamination Upon Beneficial Uses of Resources describes the effect of site contaminants on the present and future beneficial uses of site soil and water.

- Section 7.0 Summary of Remedial Action Feasibility Study describes the various alternatives identified for the site, and the screening and selection process that concluded with the recommended alternative.

- Section 8.0 Implementation Schedule describes the planned implementation dates for the remedial action.

- Section 9.0 Operation, Maintenance, and Monitoring Requirements describes the routine, ongoing and long term activities that are associated with the site and selected measure.

- Section 10.0 References presents the list of references cited in this RAP.

- Section 11.0 Glossary defines some of the specialized terms used in this report.

This RAP also includes the following appendices:

- Appendix A, Statement of Reasons prepared pursuant to Health and Safety Code Section 25356.1.
- Appendix B, Responsiveness Summary for Comments on the RAP (Reserved for the summary of comments and responses from the public review process.).
- Appendix C, Administrative Record List.

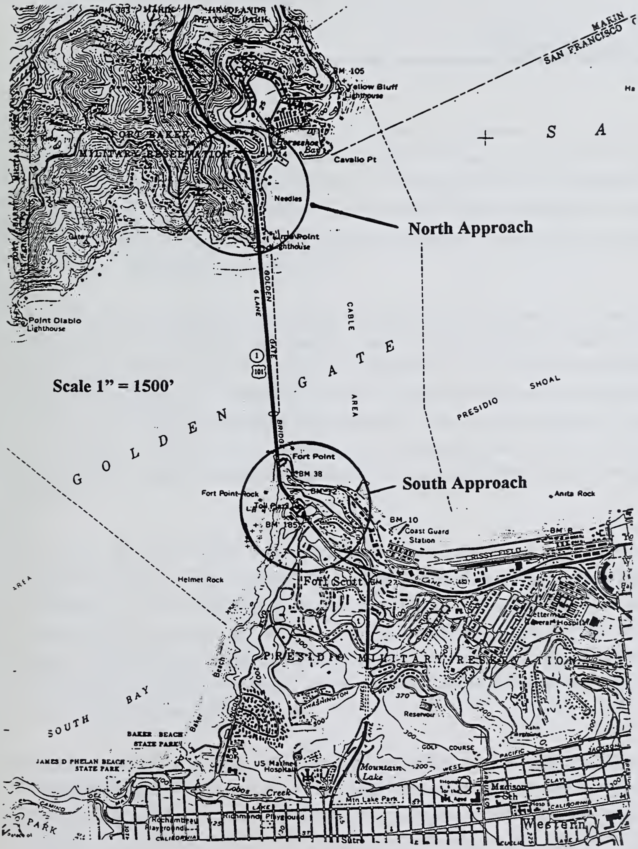


Figure 1-1. Site Vicinity Map.

This Remedial Action Plan (RAP) has been prepared in accordance with California Health and Safety Code, Chapter 6.8, Section 25356.1 for Phase I of the Lead Cleanup Project for the Golden Gate Bridge, Highway and Transportation District (GGBH&TD). It has been formatted and completed in accordance with Cal EPA Department of Toxic Substances Control (DTSC) Policy and Procedure "Remedial Action Plan Development and Approval Process" dated October 5, 1987.

The Lead Cleanup Project has been separated into two phases, comparable to Operable Units (OUs), to accommodate the engineering and scheduling constraints of the Seismic Retrofit (SR) Project. Phase I constitutes site preparation for the SR work, essentially clearing and removing of vegetation at the site and removing lead down to acceptable levels prior to subsequent excavation and construction work. Phase II will provide step-out sampling to determine the lateral extent of contamination, and will consider ecological issues and the potential ecological risk associated with lead in the environment of the site.

This RAP summarizes Phase I site investigation, human health risk assessment, and remedial alternative evaluation work. The lead contamination was found to be laterally distributed in surface sand throughout the Phase I areas. In addition to lead, zinc contamination was found in Phase I areas at the south approach. Lead was used as the target compound for investigation and risk assessment. Both lead and zinc will be used as indicators for cleanup verification. The investigation evaluated the vertical extent of lead in surface sand and underlying soil.

Remedial alternatives were assembled and evaluated for the site. Technologies that were identified through literature, current knowledge, and/or vendor surveys were first identified. A technology screening review was performed to determine the technical feasibility of application to the site. Applicable technologies were formulated into remedial alternatives that were then screened. The initial screening considered overall protection of human health and the environment, and compliance with "applicable or relevant and appropriate requirements" (ARARs), primary criteria defined by the National Oil and Hazardous Substances Pollution Contingency Plan, generally referred to as the National Contingency Plan (NCP). Remaining remedial alternatives were compared in a more detailed analysis, using all nine NCP criteria, resulting in the recommended remedial alternative.

2.1 APPROPRIATE STATE AND FEDERAL REQUIREMENTS

This RAP for Phase I of the Lead Cleanup Project is consistent with the appropriate state and federal requirements.

There are several state and federal statutes and regulations which govern remedial action plans. California Health and Safety Code, Sections 25356.1(c) through (h), 25356.3(c), 25358.6(a) through (d), and the NCP found in 40 CFR Section 300.61 et. seq. prescribe the most substantive required criteria/content for RAP development and the required approval process.

The California Environmental Quality Act (CEQA) found in Public Resources Code, 21000 et. seq., requires environmental documentation for this project. Appropriate CEQA documentation for this Phase I of the Lead Cleanup Project is included in the CEQA documentation currently being prepared for the Seismic Retrofit Project. The CEQA documentation will be released for public comment concurrent with this draft RAP.

DTSC guidance document "Remedial Action Plan Development and Approval Process" dated October 5, 1987 was followed to establish the format and ensure completeness of this RAP.

The California Code of Regulations (CCR) Title 22 and Federal Resource Conservation and Recovery Act (RCRA) rules as they apply to the management of materials classified as state or federal hazardous wastes, and the federal Clean Air Act and Clean Water Act as they apply to potential discharges of regulated substances, are included as appropriate requirements.

The state and federal requirements do not set specific standards for concentrations of lead or zinc in soil.

2.2 SITE HISTORY

The GGBH&TD was incorporated in 1928 and consists of the City and County of San Francisco, the Counties of Marin, Sonoma, Del Norte, and parts of Napa and Mendocino Counties. When the Bridge was designed in the early '30s, the design called for the standard protective coating for structural steel which was comprised of 75% red lead in linseed oil. Shortly after fabrication began in 1933, a new design for the bridge coating was introduced consisting of 32% of a synthetic vehicle and 68% red lead. This new coating was used for a majority of the structural steel prior to shipment to the west coast. The Bridge was completed in May of 1937. In 1965, due to severe corrosion, a paint replacement program was implemented to limit further corrosion of the Bridge structure. The program specified complete removal of all original red lead primers, rust and mill scale by sandblasting. The sandblasting activity is believed to be the primary source of contamination addressed in this RAP. An inorganic zinc silicate primer was specified in lieu of red lead primer for corrosion control, but initial applications on the south approach failed and were also removed by sandblasting prior to reapplications. The GGBH&TD conducted a preliminary site investigation of lead in May of 1992 and concluded its remedial investigation for Phase I in May of 1994. Most of the areas within the seismic retrofit project construction boundaries are found to contain elevated levels of lead.

2.3 SITE INVESTIGATION

The Golden Gate Bridge is situated among shale, sandstone, chert, and steep serpentine outcrops, with chert- and serpentine-derived soils of moderate depth at the south and north approaches, respectively. Surficial sand resulting from historical sandblasting activities overlies the soils underneath both approaches at depths ranging from zero to 60 inches. Sampling and analysis of the Phase I area sands and soils, begun in 1992, has found lead distributed consistently throughout the surficial sand and has defined the horizontal and vertical extent of lead contamination in the soils within the Phase I project areas. Analysis of roadbase soils at the approach areas found elevated lead concentrations only along Moore Road. The predominant nature of the lead contamination is a physical mix of lead-containing paint chips within the matrix of sand, soil, or roadbase. Some sand particles may contain lead that adhered directly to the sand grain during the sandblasting process. Soil extraction testing and analysis found the lead present to have a low water solubility, a conclusion suggested by the shallow extent of lead in on-site soils. Potential bulk particulate movement is considered a greater concern than dissolution and migration. Zinc contamination is known to exist on site and will be incorporated in the clean-up verification testing, but was not specifically investigated because activities generating zinc contamination were more recent and less extensive than historic lead sandblasting.

Groundwater is present in a confined aquifer 42 feet below ground surface at the north approach and is not used for any human use but may serve the beneficial use of replenishing springs above the north approach site. As the soil sampling results confirmed that the extent of contamination does not extend beyond an average soil depth of six inches and a maximum of 11 inches, groundwater was not investigated further. Surface water at the site is primarily storm water run-off, with some seasonal springs on the north approach. There is no use of Phase I area surface waters for industrial, agricultural, domestic, or recreational purposes; surface waters may contribute to the area's wildlife habitat. Adjacent marine waters provide navigation, ocean and commercial fishing, recreation, and habitat.

Ambient air information was acquired through monitoring stations on the Bridge and in the city of San Francisco. The topography of the Golden Gate channelizes winds in easterly flows of up to 30 miles per hour, providing good dispersal of air pollutants and good air quality. Vehicular traffic on U.S. Highway 101 generates most of the HCs, CO, and NO_x in the immediate vicinity of the Bridge. Particulate matter and lead are criteria pollutants that may exceed standards in the project area.

Plant species of the area have been disturbed by human activity, but remnant components of native northern coastal scrub, coastal bluff scrub, and non-native grassland remain. A number of factors have restricted wildlife use of the south approach to small mammals, reptiles, insects and birds; the north approach supports some additional larger mammals. Species of concern and their habitat have been identified within the Phase I area, and the project activities will be performed with applicable restrictions. Phase I areas extend only to the high tide line. Marine flora and fauna from the intertidal areas contiguous with the Phase I areas have been identified.

2.4 REMEDIAL ACTION ALTERNATIVES

Numerous remedial action alternatives were investigated. After an initial screening, the following five alternatives were given an in-depth review:

ALTERNATIVE C: EX SITU CHEMICAL FIXATION, ON-SITE USE AS STRUCTURED BACKFILL

Contaminated sand and soil would be removed for use as backfill in SR project excavations, in lieu of replacing the excavated soil. It would be treated prior to use as backfill to enhance structural characteristics and immobilize the lead. The contaminated material may be pre-treated by a physical separation method to reduce the volume that is subsequently treated by chemical fixation. The treated material would be stockpiled after cleanup, until the backfill activity occurs.

ALTERNATIVE E: EX SITU CHEMICAL FIXATION, ON-SITE USE AS ROADBASE UNDER AN ASPHALT CAP

Unpaved roads on-site may be paved in lieu of removing contaminated material. Roads must be modified for drainage, by regrading and adding additional base material. Contaminated material removed from SR construction areas would be treated for use as base, then placed below an asphalt cap. Pre-treatment by physical separation may be used to reduce the volume of contaminated material to be treated for use as roadbase.

ALTERNATIVE F: EX SITU ACID LEACHING, RECYCLE LEAD OFF-SITE, RETURN CLEANED SOIL TO SURFACE

Contaminated material removed from SR areas would be treated by acid extraction to recover lead from sand and soil in an ex situ treatment system. A lead concentrate would be recovered for resource recovery off-site, and the soil/sand would remain on-site for use as a cover.

ALTERNATIVE G: EX SITU ACID LEACHING, RECYCLE LEAD OFF-SITE, USE CLEANED SOIL AS STRUCTURED BACKFILL

Contaminated material removed from SR areas would be treated by acid extraction to recover lead from sand and soil in an ex situ treatment system. A lead concentrate would be recovered for resource recovery off-site, and the soil/sand would be stockpiled on-site for subsequent use as structured backfill in SR excavations.

ALTERNATIVE M: NO ACTION

In this alternative, no actions would be taken to treat or remove contaminated soils. The existing controls on access to the site, including fences, would be maintained. The No Action alternative is included in this detailed evaluation of alternatives as a baseline for the comparison of other remedial alternatives, according to CERCLA guidance.

2.5 RECOMMENDED ALTERNATIVE

The recommended remedial alternative is Alternative C, namely, Ex Situ Chemical Fixation, On-Site Use as Structured Backfill. This alternative encompasses the following activities:

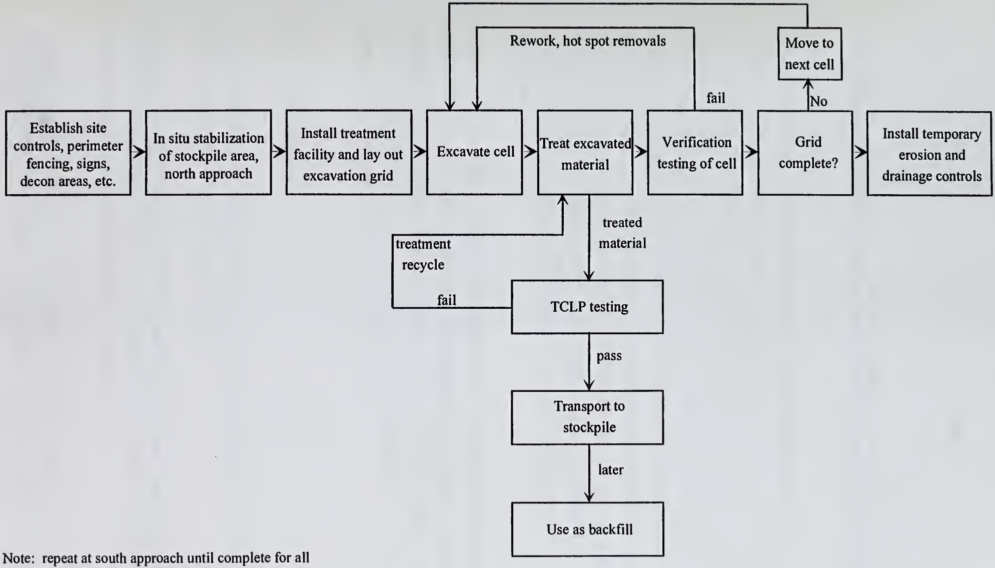
- Removal of surface sand and underlying soil in Seismic Retrofit Project construction, staging and access areas as necessary to meet cleanup goals;
- In situ treatment of the lead contaminated roadbase in the planned treatment and stockpile location at the north approach;
- Pre-treatment of material removed from Seismic Retrofit Project Areas, to reduce the volume of contaminated material. Pre-treatment may include screening, froth flotation, centrifugal separation, dry density separation, acid leaching or other physical separation methods.
- Chemical fixation of the contaminated material remaining after pre-treatment;

- Placement of the treated material into a temporary stockpile; and
- Use of the treated material as structured backfill with an engineered cap.

Figure 2-1 presents a flow chart of the proposed plan activities for the recommended remedial alternative.

2.6 ADMINISTRATIVE RECORD LIST

An administrative record list is presented in Appendix C of this document.


Establish site controls, perimeter fencing, signs, decon areas, etc.
In situ stabilization of stockpile area, north approach
Install treatment facility and lay out excavation grid
Excavate cell
Treat excavated material
Verification testing of cell
Grid complete?
Install temporary erosion and drainage controls
Move to next cell
No
fail
Rework, hot spot removals
treated material
treatment recycle
fail
TCLP testing
pass
Transport to stockpile
later
Use as backfill

Note: repeat at south approach until complete for all cells, then move treatment system and repeat cycle for north approach

Figure 2-1. Golden Gate Bridge Phase I, Lead Removal Project - Removal Action Flow Chart.

3.0
DETAILED DESCRIPTION OF SITE CHARACTERISTICS

The site consists of two separate areas, the north and south approaches to the Golden Gate Bridge. The two areas are included in this RAP, and referred to collectively as "the site." When referred to separately the terms "south approach" or "north approach" are used. The south approach is located at the Fort Point National Historic Site area within the Golden Gate National Recreation Area, on the Presidio in the city and county of San Francisco. The north approach is located at the Lime Point area at East Fort Baker, in the county of Marin. The site ownership was transferred from the Department of Defense (DOD) to the Department of the Interior (DOI) on October 1, 1994, and is under permit to Golden Gate Bridge Highway and Transportation District (GGBH&TD). The approach areas are used for bridge and highway access and maintenance and for tourism and recreation.

This RAP is for Phase I of the Lead Cleanup Project. The Phase I areas are immediately below the elevated roadway portions of the bridge approaches, and are the areas that will be affected by the Seismic Retrofit Project. Other areas will be considered during Phase II of the Lead Cleanup Project. The terrain of the site varies from mildly sloped to very steep, and includes dense vegetation in some areas.

3.1 SITE HISTORY

A brief summary of important dates in site history follows, with discussion of historic paint formulations and paint program history:

December 4, 1928 - Golden Gate Bridge and Highway District incorporated. The District consists of City and County of San Francisco, and Counties of Marin, Sonoma, Del Norte, and parts of Napa and Mendocino Counties.

August 15, 1929 - Joseph B. Strauss appointed Chief Engineer of District to design and build the Golden Gate Bridge. When design of the Golden Gate Bridge began in the early 1930's the standard protective coating for structural steel was 75% red lead in linseed oil.

January 5, 1933 - Actual construction of the Golden Gate Bridge began. Shortly after fabrication began, a new design consisting of 32% of a synthetic vehicle and 68% red lead was specified and used. This new coating was used for the majority of the structural steel prior to shipment to the west coast.

May 27, 1937 - Golden Gate Bridge completed and opened to pedestrian traffic - and to vehicular traffic the following day, May 28, 1937.

1965 - Due to severe corrosion, a paint replacement program was implemented to limit further corrosion. The program specified complete removal of all original red lead primers, rust, and mill scale by sandblasting. Use of an inorganic zinc silicate primer was specified in lieu of lead primer for corrosion control. Initial zinc applications on the south approach failed and were removed by sandblasting prior to reapplication.

May 1992 - The GGBH&TD conducted a preliminary site investigation of lead.

November 1993 - The GGBH&TD conducted a pilot demonstration of vacuum removal of sand and soil and handheld x-ray fluorescence (XRF) testing technology using a Cobalt 57 radiation source. The handheld XRF device allows field analytical testing to determine the concentration of various metals in soil, in situ or ex situ.

December 1993 - The GGBH&TD conducted a second test of handheld XRF testing technology using a Cadmium 109 radiation source.

May 1994 - The GGBH&TD concluded its site remedial investigation of the extent of lead contamination within the Seismic Retrofit Project areas.

November 1994 - The GGBH&TD completed its feasibility study, evaluating remedial alternatives applicable to Phase I of the Lead Cleanup Project.

3.1.1 LOCATION

There are two areas of the site, the north approach and the south approach to the Golden Gate Bridge. The south approach is located at Fort Point National Historic Site area within the Golden Gate National Recreation Area, on the Presidio in the city and county of San Francisco. The north approach is located at the Lime Point area at East Fort Baker, in the county of Marin. The site ownership was transferred from the Department of Defense (DOD) to the Department of the Interior (DOI) on October 1, 1994, and is under permit to Golden Gate Bridge Highway and Transportation District (GGBH&TD). The approach areas are used for bridge and highway access and maintenance and for tourism and recreation. The site and its surroundings are shown in Figure 1-1. The south approach is presented in greater detail in Figure 3-1, and the north approach is presented in Figure 3-2.

3.1.2 NATURE OF BUSINESS AND LENGTH OF OPERATION

The Golden Gate Bridge opened to vehicle traffic on May 28, 1937. The GGBH&TD operates and maintains the bridge and toll plaza as well as a gift shop and gardens. The GGNRA operates and maintains the Fort Point historic site and the Lime Point Lighthouse.

3.1.3 TYPES OF CHEMICALS AND THEIR USE

When design of the Golden Gate Bridge began in the early 1930's the standard protective coating for structural steel was 75% red lead in linseed oil. Shortly after fabrication began, a new design consisting of 32% of a synthetic vehicle and 68% red lead was specified and used. This new coating was used for the majority of the structural steel after fabrication, prior to shipment to the west coast. An inorganic zinc silicate primer is now used in lieu of lead primer for corrosion control (Lindsay, GGBH&TD, undated).

The site soil may contain lead from other sources. Automotive fuels historically contained lead, and resultant lead aerosols in vehicle exhaust has been identified as a source of soil contamination along highways. The site also includes historic military facilities where lead use for facilities and ammunition is probable. Current buildings in the Presidio, Fort Baker, and the former building on the Lighthouse Keeper's Bluff were probably painted with lead based paint.

3.1.4 CHEMICAL RELEASE EVENTS

In 1965, due to severe corrosion of bridge structures, a paint replacement program was implemented to limit further corrosion. The program specified complete removal of all original red lead primers, rust, and mill scale by sandblasting. Lead removal from structures at the south approach was completed by 1975. Lead removal by open sandblasting from structures at the north approach was completed in 1994. Initial applications of the new zinc primer did not properly adhere, and portions of the structure at the south approach were sandblasted to remove the zinc primer, prior to reapplication. These sandblasting activities are believed to be the principal source of contamination in the Phase I cleanup areas.

Phase I areas in close proximity to Highway 101 were subject to historic deposition of lead in the form of aerosols from combustion of leaded motor fuels. Typical lead concentrations within 10 meters of roadways have been reported to range up to 2,017 ppm, with a mean value of 1,920 ppm, and drop rapidly with distance from the road with a maximum of 203 ppm and mean of 53 at distances over 30 meters (Davies, 1988).

The site also has a military history, and the use of lead in munitions is likely, but specific documentation is not available. Lead paint was probably used on buildings in the Presidio and Fort Baker, as well as the former building on the Lighthouse Keeper's Bluff. Lead in some urban areas is primarily attributed to the degradation of lead paint (McIntyre and Mahoney, 1988; Rabinowitz, 1988).

3.1.5 CHRONOLOGY OF SITE INVESTIGATION AND REMEDIAL ACTIVITIES

In May of 1992 the GGBH&TD conducted a preliminary investigation of lead contamination in the bridge area. Results showed areas of lead contamination in soils immediately under the approach structures (Health Science Associates, May 1992). The Golden Gate National Recreation Area (GGNRA) performed additional sampling which extended to locations beyond the bridge easements and found additional lead contamination in the vicinity of the Lighthouse Keeper's Bluff (Questa Engineering, June 1992). In July of 1992 the results from these sampling events, and GGBH&TD discussion with DTSC resulted in a fence and post order from DTSC. Fence and Post Order Docket Number FP 92/93-001, was issued on July 15, 1992 to the GGBH&TD, the GGNRA, and the U.S. Army, Presidio of San Francisco. The approximate location of the area addressed by the fence and post order is shown on Figures 3-1 and 3-2.

In November of 1993 the GGBH&TD conducted a field demonstration of vacuum removal of sand and soil. The vehicle was monitored for particulate emissions. A handheld x-ray fluorescence (XRF) device with a cobalt 57 source was also tested. This was followed by testing of an XRF device with a cadmium 109 source, in December 1993.

In May of 1994 the results of an investigation of the vertical extent of sand and soil contamination in the Phase I Project areas were reported (ENTRIX, May 1994). The Preliminary Vertical Delineation Work Plan was designed to develop sufficiently accurate data to estimate quantities of sand and soil that must be removed prior to the Seismic Retrofit excavation. Detailed design work and bid specifications required the development of a vertical and horizontal profile of lead distribution.

3.1.6 INTERIM REMEDIAL MEASURES

No specific remediation or removal actions have occurred at the site, and one administrative measure has been implemented to protect human health. In accordance with the July 15, 1992 fence and post order, the GGBH&TD has implemented the administrative measure of fencing the site and posting warnings to restrict public access to the site.

3.1.7 OTHER SIGNIFICANT INFORMATION

The lateral extent of the Phase I area is based on Seismic Retrofit Project requirements and generally contains lead in sand at levels in excess of the health based cleanup level. Investigation in the Phase I areas was therefore limited to examining the vertical distribution of lead in soil, and measurement of the depth of sand, to allow calculation of quantities for the remediation. Full CEQA documentation for this lead remediation project is provided through the Seismic Retrofit Project, for which this Phase I Lead Cleanup Project constitutes site preparation.

3.2 PHYSICAL DESCRIPTION

The Phase I areas are immediately below the elevated roadway portions of the approaches to the bridge. The terrain varies from mildly sloped to very steep, and includes dense vegetation in some areas. The following sections provide specific information on the nature and use of the site.

3.2.1 TOPOGRAPHY

The site was divided into human accessible and human inaccessible zones based on topography and vegetation. The Phase I areas encompass the majority of the human accessible portion of the site. At the north approach virtually all of the accessible zones are included in Phase I. At the south approach an accessible area outside specific seismic retrofit construction, staging or access areas, is the area known as Lighthouse Keeper's Bluff. The bluff is included in the Phase I lead removal project for remediation for these reasons: 1) the Army Department of Public Works has requested that the GGBH&TD clean the bluff area to clear the path for proposed utility piping; 2) cleanup contractors and equipment will be mobilized in the area; 3) the bluff is adjacent to areas being cleaned; and 4) the elevated bluff may be a source of run-off to other areas.

The human accessible zone, outside of the Seismic Retrofit Project areas, includes paved trails and roads, unpaved trails and roads, and unpaved open areas lacking specifically defined trails or paths. These areas are not included in the scope for Phase I work, but will be addressed in Phase II.

The human inaccessible areas include steep terrain and/or dense vegetation. Inaccessible areas are not included in the scope for Phase I work, but will be addressed in Phase II.

Site elevation varies from the high tide line up to approximately 220 feet above mean sea level.

3.2.2 AREAL EXTENT OF CONTAMINATION

In the Seismic Retrofit Project construction and staging areas, the lateral extent of contamination is assumed to include the entire footprint of those areas, plus limited additional accessible areas such as the Lighthouse Keeper's Bluff. Thus the lateral extent is defined by engineered limits, terrain, or vegetation, rather than by contaminant levels or other criteria. The determination of the lateral extent of contamination beyond these limits will occur in Phase II of the Lead Cleanup Project.

3.2.3 CURRENT USES OF THE PROPERTY

The Phase I areas are used for access to bridge support structures for maintenance purposes, by GGNRA work crews, and for tourism and recreation.

3.2.4 SURROUNDING LAND USE

Areas directly adjacent to the Phase I Lead Cleanup Remedial Action Site include both recreational and historic properties of national and international prominence including:

- Golden Gate Bridge visitor areas on the southeast side of the Bridge adjacent to the Toll Plaza including the East Parking Lot, Roundhouse Gift Center, Gardens and Scenic Overlook areas.
- Golden Gate Bridge operations and maintenance facilities located on the southwest side of the Bridge include the Toll Plaza, District Administration Building, and satellite buildings housing Bridge Maintenance, Data Processing, Engineering and District Services.
- Historic Fort Point is a National Historic Site and a contributory to the Presidio of San Francisco which is a National Historic Landmark. Fort Point is listed on the National Register and is a Civil Engineering Landmark, but is not designated a State of California Landmark.

- Fort Baker Military Reservation historically served the various gun batteries protecting the Golden Gate. The East Fort Baker area adjacent to Horseshoe Bay includes military housing and an active Coast Guard station as well as Lime Point and the associated Coast Guard light station. Fort Baker is listed on the National Register of Historic Places.

- Golden Gate National Recreation Area is a park to the north and south of the Golden Gate. GGNRA follows the Pacific shoreline encompassing redwood forests, beaches, grassy hillsides, marshes and rocky shoreline. The uses of the GGNRA in the vicinity of the project site include shoreline access for fishing and recreation, hiking, tourism, and the Bay Area Discovery Museum, a hands-on museum for children.

- Vista Point, a turnout off of Highway 101 used for viewing the Golden Gate, the Bridge, and San Francisco, is adjacent to the site at the north approach and is operated by CalTrans.

3.2.5 DEMOGRAPHY

The Phase I Lead Cleanup Project remedial action site is not located within a specific community as it is located on federal lands. The Phase I site is comprised of employment, recreational and visitor areas. Specific uses of the site were identified and considered as part of the human health risk assessment.

3.2.6 LOCATION AND DISTANCE TO BIOLOGICAL RECEPTORS

Potential human receptors and exposure pathways have been identified and potential risks quantified based on pharmacokinetic effects to blood lead levels. The potential human receptors include tourists, recreational users, and workers from the GGBH&TD and GGNRA. Implementation of the fence and post order has restricted site access for tourist and recreational use.

Potential biological receptors, as identified in environmental documents prepared for the overall Seismic Retrofit Project include terrestrial wildlife and marine communities. The

Draft Biological Assessment and Administrative Draft Environmental Assessment are the source of subsequent discussion of biological receptors. These reports were developed in consultation with the U.S. Fish and Wildlife Service.

Because the south approach is subjected to regular human disturbance, is exposed to nearly constant winds, and is composed of scant patches of vegetation on shallow soils, wildlife use of this area is generally restricted to small mammals, reptiles, insects, and bird use. On the north approach an occasional coyote or bobcat may visit the area to prey on these common rodents and birds. A black-tailed deer has been observed adjacent to the northern anchorage housing during site visits. Other species commonly found in this habitat include small mammals such as the deer mouse and California meadow mouse; reptile species such as the western fence lizard, and gopher snake; and common bird species such as Brewer's blackbird, American robin, lark sparrow, and western meadowlark.

The Phase I areas extend only to the high tide line. Rocky intertidal areas contiguous with the Phase I areas support flora and fauna that live attached to the substrate and tend to be distributed in zones related to tidal height. Most of these forms either burrow into or attach themselves to the concrete bridge structures and the rocky areas surrounding these structures. In shallow (less than 20 meter water depth) sandy areas, tube worms are generally the dominant invertebrate, although other organisms do exist. In the area offshore of San Francisco and Marin beaches, dense beds of sand dollars can exist in sandy habitats in the five to ten meter depth zone. The rich plankton of the area supports, directly or indirectly, large populations of seabirds and marine mammals that inhabit the California coastal environment. These populations depend on the krill, squid, and planktivorous fish that abound in areas of upwelling.

In the Golden Gate between the north approach and south approach, there is an abundance of open water fishes, including the northern anchovy, Pacific bonito, jack mackerel, and Pacific mackerel. Species more abundant in shallow sandy and silty bottom areas include speckled sanddab, sand bass, queenfish, white croaker, rainbow surfperch, dwarf surfperch, and dover sole.

Many species of dolphins have been identified in surveys of the bay and nearshore coastline. Some of these species are year-round residents, some seasonal migrants, and others rare visitors. The California gray whale is the most common whale in the area, and the one most likely to occur near shore. Four common species of seal occur in the region. These include California sea lion, northern fur seal, northern elephant seal, and harbor seal. Peak number of animals are on land during the breeding season (February to May), and during the early summer molting season. Sea otters occasionally appear in the nearshore waters of the Golden Gate near the project area (ESA, March 1994).

Species of concern within the project area include the Mission Blue Butterfly (*Icaricia [-Plebejus] icarioides missionensis)*, and the San Francisco Tree Lupine Moth (*Grapholita edwardsiana [Olethreutidae]*). The American Peregrine Falcon (*Falco peregrineus anatum*) is also known to have nested in the vicinity of the north approach. The Phase I remedial action will be performed in accordance with restrictions on the Seismic Retrofit Project, including dust control, buffer zones, biological monitoring, and potential seasonal work restrictions associated with protection of the Mission Blue Butterfly.

3.2.7 CLIMATOLOGY

The San Francisco Bay Area enjoys a mild Mediterranean climate, characteristic of much of coastal California but locally modified by the prevalence of coastal fogs, especially during the summer months (U.S. Weather Bureau Data).

The site and its location adjacent to the Golden Gate is particularly subject to coastal fog and wind, and temperatures moderated by the ocean throughout the year. The area receives an average of approximately 20 inches of rain per year with 85 to 95 percent of the precipitation occurring during the period of October through March. Temperatures average from 50 to 60° F in winter and 60 to 70° F in summer.

Wind consistently flows across the bridge in an easterly direction, up to 30 miles per hour (ESA, August 1994).

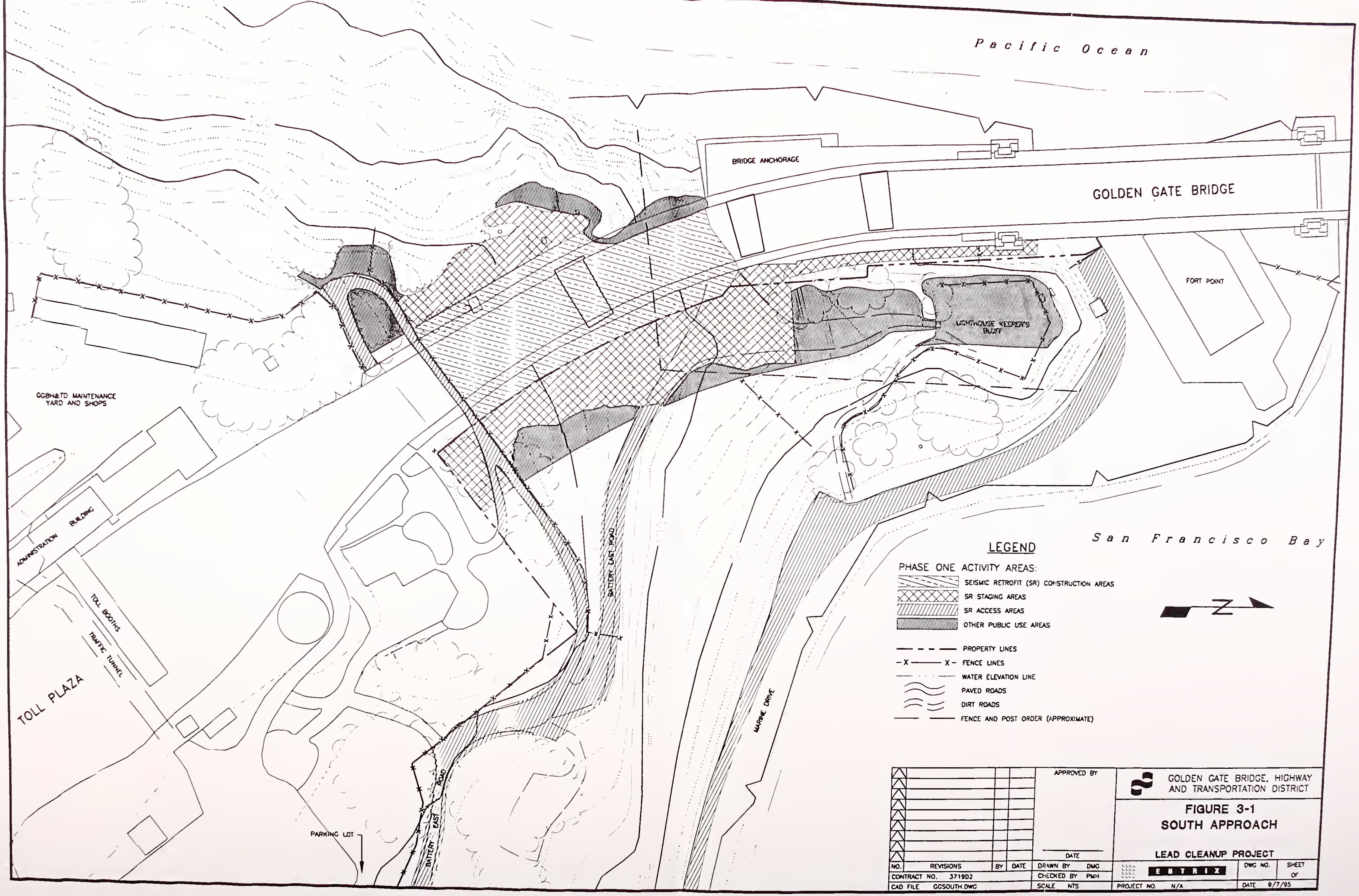
3.2.8 LOCATION OF NEAREST WATER WELL

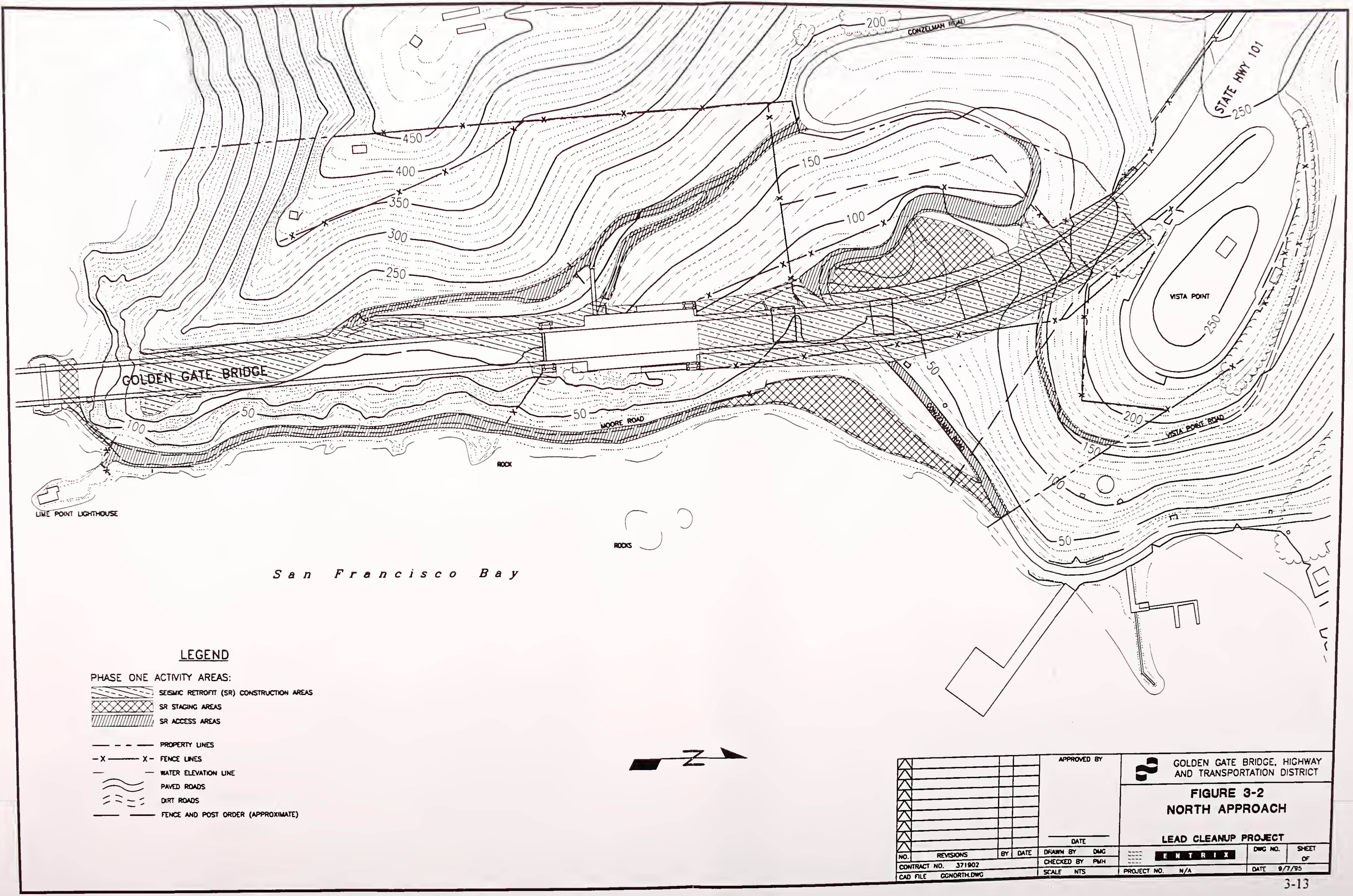
Based on field observation within the Seismic Retrofit project areas and communications with the Army and GGNRA, no groundwater supply wells are known to exist on-site within the APE.

Potable water in the Presidio and the facilities operated by the GGBH&TD at the south approach originates as surface water from Lobos Creek within the Presidio. There are groundwater wells located near the Lobos Creek outfall that are available to supplement the Presidio potable water supply. Those wells are one mile from the site and are topographically separated from the south approach (Watkins-Johnson, 1993). Groundwater from the Lobos Creek watershed is also pumped for irrigation of the Presidio golf course. The GGBH&TD maintains groundwater monitoring wells associated with underground fuel storage tanks near their maintenance facilities at the south approach.

There is no potable water available on-site at the north approach. A water supply pipe passes through the north approach, supplying water for CalTrans and visitor use at Vista Point and along Highway 101. The potable water supply originates from the Marin Municipal Water District. There is no knowledge of any drinking water supply wells south of Sausalito or within the federal lands of the GGNRA in the vicinity of the north approach.

The locations of the nearest known groundwater extraction wells are shown on Figure 3-3.


Pacific Ocean
BRIDGE ANCHORAGE
GOLDEN GATE BRIDGE
FORT POINT
LIGHTHOUSE KEEPER'S BLUFF
GGBH&TD MAINTENANCE YARD AND SHOPS
ADMINISTRATION BUILDING
TOLL BOOTHS
TRAFFIC TUNNEL
TOLL PLAZA
BATTERY EAST ROAD
MARINE DRIVE
PARKING LOT
San Francisco Bay
LEGEND
PHASE ONE ACTIVITY AREAS:
SEISMIC RETROFIT (SR) CONSTRUCTION AREAS
SR STAGING AREAS
SR ACCESS AREAS
OTHER PUBLIC USE AREAS
PROPERTY LINES
FENCE LINES
WATER ELEVATION LINE
PAVED ROADS
DIRT ROADS
FENCE AND POST ORDER (APPROXIMATE)
N
APPROVED BY
DATE
NO.
REVISIONS
BY
DATE
DRAWN BY DMG
CHECKED BY PMH
SCALE NTS
CONTRACT NO. 371902
CAD FILE GGSOUTH.DWG
GOLDEN GATE BRIDGE, HIGHWAY AND TRANSPORTATION DISTRICT
FIGURE 3-1
SOUTH APPROACH
LEAD CLEANUP PROJECT
ENTRIX
DWG NO.
SHEET OF
PROJECT NO. N/A
DATE 9/7/95



GOLDEN GATE BRIDGE, HIGHWAY AND TRANSPORTATION DISTRICT

FIGURE 3-2
NORTH APPROACH

LEAD CLEANUP PROJECT

NO.	REVISIONS	BY	DATE

CONTRACT NO. 371902
CAD FILE GGNORTH.DWG

APPROVED BY
DATE
DRAWN BY DMG
CHECKED BY PMH
SCALE NTS

ENTRIX
PROJECT NO. N/A
DWG NO.
SHEET OF
DATE 9/7/95

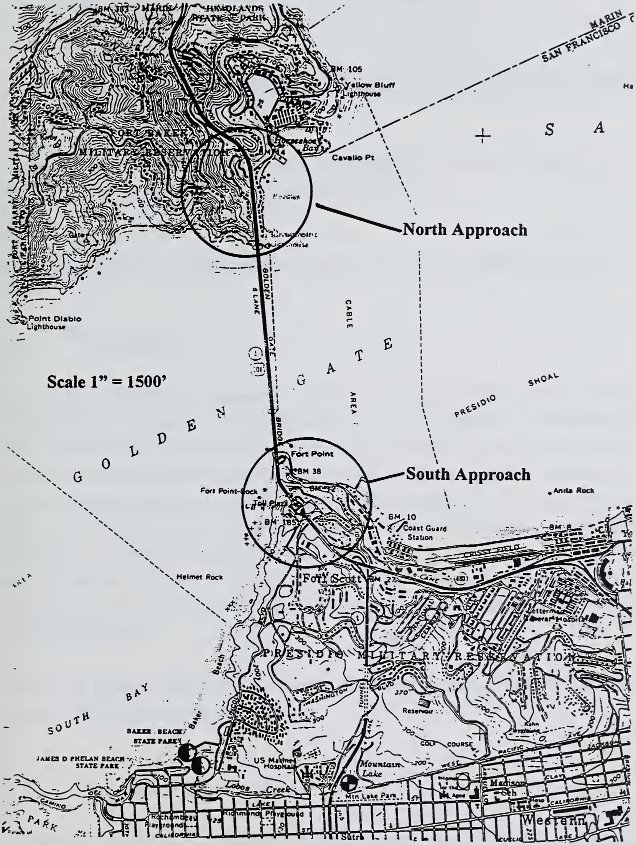


Figure 3-3. Location of Nearest Water Wells.

◐ DRINKING WATER

◒ IRRIGATION WATER

4.0

SUMMARY OF REMEDIAL INVESTIGATION (RI) FINDINGS

The remedial investigation for the Phase I RAP defined the lateral and vertical extent of the lead contamination in sand and soil within the Phase I area.

4.1 GEOLOGICAL INVESTIGATION OF SITE AND IMMEDIATELY ADJACENT AREA

4.1.1 SITE GEOLOGY

The Golden Gate Bridge is completely underlain by rocks of the Franciscan series of late Jurassic or early Cretaceous periods. Franciscan rocks are composed of highly modified shale and sandstone, radiolarian chert, and extensive serpentine outcrops, which occur intermittently along a diagonal zone extending from Fort Point on the southern shore of the Golden Gate across San Francisco to Potrero Hill and Hunters Point on the Bay shore. The area below the north side of the bridge is primarily steep slopes covered with Tamalpais - Barnabe Variant gravely loams. This soil is shallow to moderately deep and well drained and is formed of material derived from chert. The area below the south side of the bridge is also steep but made-up primarily of serpentine with a sand overcovering (ESA, August 1994).

As part of seismic stability and foundation studies deeper geotechnical borings were made to confirm site specific geology.

4.1.2 ASSESSMENT OF CONTAMINANTS IN SOIL

A majority of the site is covered with sand resulting from historical sandblasting activities. Sand depths were measured at approximately 180 locations. Results of all analyses are plotted on Figures 4-1 (South Approach) and Figure 4-2 (North Approach). Actual depths and the locations of measurement points are plotted on Figure 4-3 (South

Approach) and Figure 4-4 (North Approach). Sand depths range from zero at several locations to an estimated 60 inches along the east side of the south anchorage. Sampling conducted from 1992 to date consistently found surface sand within Phase I areas to contain lead above the site specific risk based cleanup level. Thirty-six shallow core samples were collected at 30 locations and analyzed for total lead at four different depths. Three triplicate samples were collected at Location 9, Location 16, and Location 21. Triplicate results are reported as averages.

Deeper soil samples were taken at three locations (1, 2, and 3) to a depth of 6.7 feet, 20.5 feet, and 20.5 feet, respectively. These three locations were known to have been excavated during the course of sandblasting and lead paint removal on the overhead structures. Locations of the deep core samples are shown on Figure 4-1 (South Approach) and Figure 4-2 (North Approach). Continuous cores were retrieved from the borings in 18-inch stainless steel tubes. Samples were selected for analysis on the basis of lithological changes and other apparent variations, such as paint chips and moisture content. Analyses were performed for depths of 2.5 and 6.7 feet at Location 1, and for depths of 2.5, 7, 11.5, 16, and 20.5 feet at Locations 2 and 3. No replicate sampling was conducted at the deep core locations.

Cores were collected from fifty-seven locations on unpaved roads. Fifty locations (including one triplicate) were sampled on the north approach and seven locations (including one triplicate) were sampled on the south approach. Depths of samples ranged from one inch to eighteen inches. Analyses for total lead were requested of all one-inch samples. For all cores with lead concentrations ≥1,500 ppm at one-inch, analysis was requested for the seven-inch depth. No samples exceeded 1500 ppm at the seven-inch depth. Sample locations and analytical results are plotted on Figure 4-5 (South Approach) and Figure 4-6 (North Approach).

Lead concentrations were interpolated or extrapolated as necessary to estimate the volume of material which is impacted at greater than the human health risk based cleanup level. The concentration/depth profile and road area was used to calculate a removal quantity. Only Moore Road, adjacent to San Francisco Bay on the north approach, was found to have lead concentrations above the cleanup level.

The extent of lead in surface sand and soil extends laterally throughout the Seismic Retrofit Project areas. The vertical extent includes surface sand and underlying soil.

Sand depths vary from zero up to five feet, with all sand accumulations within the Phase I area found to contain lead in excess of cleanup levels. Soil depths from zero to eleven inches have been found to contain lead concentrations above the risk based cleanup level.

The nature of the contamination in sand, soil, and roadbase is a physical mix of paint chips within the sand, soil, or roadbase matrix. The paint chips vary in size from about 1/2" across down through dust. The lead in paint chips is bound in a linseed oil or synthetic based organic resin. In addition to paint chips, contaminated sand may include sand particles with lead bound to the surface. This adhesion may occur during sandblasting, due to heat generated at the point of impact of sand with the surface being cleaned.

Zinc based coating is known to have been sandblasted off the structure on portions of the south approach. The site remedial investigation did not specifically characterize zinc, as zinc coating sandblasting is more recent and more limited than historic lead paint sandblasting. However, zinc analysis will be incorporated in the verification testing conducted in the Phase I area.

Extraction testing and analysis was performed to test for dissolution of lead in water. Testing of sandy soil samples with deionized water (di H_2O) gave the following results. These results are compared to those using a weak acid (TCLP).

Lead Extraction Test Results

Sample Type	Lead (ppm)	TCLP (mg/l)	TCLP, di H_2O (mg/l)
sand, grab	6,500	83.0	0.56
soil, grab	1,500	5.0	0.82
soil core	1,300	0.15	1.5
soil core	61	0.69	0.26

The relatively shallow extent of lead in the soil also indicates low solubility into percolating surface water. The contamination assessment conclusion is that lead migration through dissolution is not a concern relative to potential bulk particulate movement by surface run-off.

4.2 HYDROGEOLOGIC INVESTIGATION

4.2.1 GROUNDWATER

Groundwater is found in shallow discontinuous sand lenses and in a confined aquifer above bedrock in the valley below the viaduct section of the north approach. The depth to the confined aquifer is approximately 42 feet below ground surface at tower 3, near Conzelman Road (Geospectra, June 1994). The direction of groundwater flow is expected to be downgradient towards the shoreline according to the surface topography. Groundwater from within the Phase I area is not used for drinking water, irrigation, or for any other human use. At the north approach there are upgradient springs in the area that provide intermittent seasonal surface flows through the Phase I project site.

The only current beneficial use of groundwater may be the fresh water replenishment to surface water associated with the springs above the site at the north approach. The confined aquifer below the north approach may be considered a potential source of drinking water as defined by the Regional Water Quality Control Board (RWQCB) San Francisco Bay Basin Plan.

As the sampling results confirmed that the extent of contamination is limited to surface sand plus an average of six inches of surface soil, groundwater was not further investigated.

4.2.2 SURFACE WATER

Surface water at the site is primarily storm water run-off, with some springs contributing to seasonal flows through the site on the north approach. Evidence of surface water transport of particulate including paint chips is visible in eroded surface drainage pathways, with sand buildups behind roots, rocks, and in flat areas where flow velocities are relatively low. There is no use of surface water on the Phase I site for industrial process or service supply, municipal or domestic water supply, agricultural or irrigation supply, or recreation. The surface water may contribute to wildlife habitat, including habitat associated with threatened or endangered species.

Surface water from Lobos Creek in the adjacent Presidio is used for drinking water. The source for that drinking water is on the south side of the Presidio, approximately 1 mile from the site, and separated from the south approach by a topographic ridge (Watkins-Johnson, 1993). Adjacent marine waters provide navigation, ocean and commercial fishing, recreation and habitat including fish migration.

4.3 AMBIENT AIR

The subsequent discussion of air quality is based on the Administrative Draft, Environmental Assessment, for the Seismic Retrofit Project (ESA, August 1994). Confidence in the ability of dust control measures to be effective during remediation is based upon monitoring during a pilot test on-site (ENTRIX, December 1993).

4.3.1 DESCRIPTION OF AMBIENT AIR QUALITIES

The primary factors that determine air quality are the locations of air pollutant sources and the amounts of pollutants emitted. Meteorological and topographical conditions, however, are also important. Atmospheric conditions such as wind speed, wind direction, and air temperature gradients interact with the physical features of the landscape to determine the movement and dispersal of air pollutants.

The San Francisco Bay area has a Mediterranean climate, with a mild rainy season from November through March, and warm, dry weather from June through September. Movements of marine air through the Golden Gate depend on the location and strength of the dominant Pacific high-pressure system and the coastal temperature gradient. In summer, strong northwesterly winds generated by high-pressure systems are drawn through the Golden Gate and forced to the east. The Marin headlands and San Francisco hills channelize winds through the Golden Gate, providing dispersal of air pollutants and good air quality.

The GGBH&TD operates a meteorological station on the bridge's mid span. Data from this station indicate that winds consistently flow across the bridge in an easterly direction up to 30 miles per hour.

Vehicular traffic on U.S. Highway 101 generates most of the HCs (O_3 precursors), CO, and NO_x in the immediate vicinity of the Golden Gate Bridge. PM_{10} emissions are a result of entrained road dust by automobiles, wind erosion of exposed soil, and sea mist from the Pacific Ocean. The BAAQMD operates a network of air quality monitoring stations within the San Francisco Bay Area Air Basin. The station nearest the Golden Gate Bridge is on Ellis Street, a busy commercial street at the edge of downtown San Francisco. Some pollutant levels measured at the Ellis Street station may be representative of the project site due to their regional nature; others, such as CO, are localized and would not be accurately characterized by measurements at the Ellis Street Station. The criteria pollutants that may exceed standards in the project area are Respirable Particulate Matter (PM_{10}) and Lead (Pb).

Respirable Particulate Matter (PM_{10})

PM_{10} consists of particulates 10 microns or less in diameter, which can be inhaled and cause adverse health effects. Particulates in the atmosphere result from many kinds of dust and fume-producing industrial and agricultural operations, combustion, and atmospheric photochemical reactions. Demolition, construction, and vehicular traffic are major sources of particulates in urban areas. Natural sources of particulates include wind erosion from exposed surfaces. Very small particles of certain substances (e.g., sulfates and nitrates) can cause lung damage directly, or can contain absorbed gases (e.g., chlorides or ammonium) that may be injurious to health. Exceedences of the federal and state PM_{10} standard occur occasionally near the project site (ARB, 1989-1992; BAAQMD, 1994).

Lead (Pb)

Gasoline-powered automobile engines used to be the major source of airborne lead in the urban areas, but are no longer the major source since leaded fuels have been phased out of the gasoline market. Lead can cause hematological (blood-related) effects, such as anemia (iron-deficient blood) and inhibition of enzymes involved in blood synthesis (Sittig, 1985). Ambient levels in the Bay Area are well below the ambient standard and are expected to continue to decline. The lead standards have not been exceeded at the Ellis Street station in the last five years (ARB, 1989-1992; BAAQMD, 1994).

4.4 BIOLOGICAL INVESTIGATION

Biological studies to support the Seismic Retrofit Project environmental documentation have been performed (ESA, January 1994). Further ecological risk assessment studies will be included in Phase II.

4.4.1 DESCRIPTION OF HABITATS

Plant species of the area are a combination of north coastal and south interior elements with a number of species reaching a northern or southern distributional limit. Serpentine rocks and the soils derived from them on the south approach have a high magnesium and low calcium content, the latter being a limiting factor to plants, creating an environment with a unique flora adapted to those conditions. Vegetative communities within the area below the south side of the bridge have been more disturbed than the northern side due to human activity. Although the land has been degraded due to bridge construction, maintenance, visitors, and introduction of exotic plants, the area still supports remnant components of northern "Franciscan" coastal scrub, non-native grassland (primarily north approach) and northern coastal bluff scrub (primarily south approach).

Terrestrial Wildlife

Scrub communities such as northern coastal bluff scrub and northern "Franciscan" coastal scrub support several important food plants including sage, California blackberry, poison oak, and various grass species, which in turn support a variety of wildlife. Because the south side of the bridge is subjected to regular human disturbance, is exposed to nearly constant winds, and is composed of scant patches of vegetation on shallow soils, wildlife use of this area is generally restricted to small mammals, reptiles, insects, and bird use. On the north side of the project site an occasional coyote or bobcat may visit the area to prey on these common rodents and birds. A black-tailed deer has been observed adjacent to the northern anchorage housing during site visits. Other species commonly found in this habitat include small mammals such as the deer mouse and California meadow mouse; reptile species such as the western fence lizard, and gopher snake; and common bird species such as Brewer's blackbird, American robin, lark sparrow, and western meadowlark.

Species of Concern

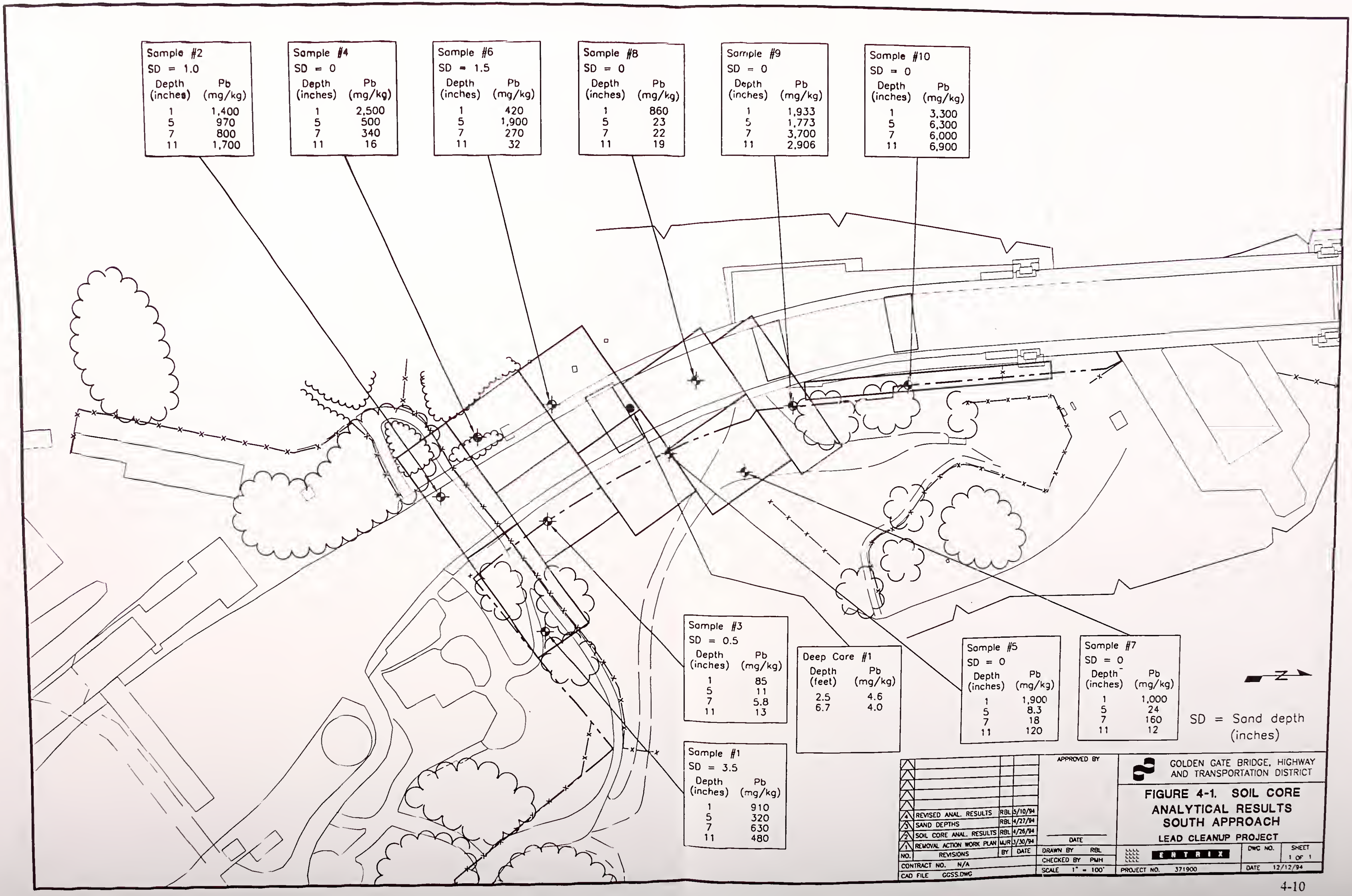
Species of concern within the project area include the Mission Blue Butterfly (*Icaricia [-Plebejus] icarioides missionensis)*, and the San Francisco Tree Lupine Moth (*Grapholita edwardsiana [Olethreutidae]*). The American Peregrine Falcon (*Falco peregrineus anatum*) is also known to have nested in the vicinity of the north approach. The Phase I remedial action will be performed in accordance with restrictions on the Seismic Retrofit Project, including dust control, buffer zones, biological monitoring, and potential seasonal work restrictions.

Marine Communities

Phase I areas extend only to the high tide line. The flora and fauna of rocky intertidal areas contiguous with the Phase I areas live attached to the substrate and tend to be distributed in zones related to tidal height. Most of these forms either burrow into or attach themselves to the concrete bridge structures and the rocky areas surrounding these structures. In shallow (less than 20 meter water depth) sandy areas, tube worms are generally the dominant invertebrate, although other organisms do exist. In the area offshore of San Francisco and Marin beaches, dense beds of sand dollars can exist in sandy habitats in the five to ten meter depth zone. The rich plankton of the area supports, directly or indirectly, large populations of seabirds and marine mammals that inhabit the California coastal environment. These populations depend on the krill, squid, and planktivorous fish that abound in areas of upwelling.

In the Golden Gate there is an abundance of open water fishes, including the northern anchovy, Pacific bonito, jack mackerel, and Pacific mackerel. Species more abundant in shallow sandy and silty bottom areas include speckled sanddab, sand bass, queenfish, white croaker, rainbow surfperch, dwarf surfperch, and dover sole.

Many species of dolphins have been identified in surveys of the bay and nearshore coastline. Some of these species are year-round residents, some seasonal migrants, and others rare visitors. California gray whale is the most common whale in the area, and the one most likely to occur near shore. Four common species of seal occur in the region. These include California sea lion, northern fur seal, northern elephant seal, and harbor seal. Peak number of animals are on land during the breeding season (February to May), and during the early summer molting season. Sea otters occasionally appear in the nearshore waters of the Golden Gate near the project area.



Sample #2

SD = 1.0

Depth (inches)	Pb (mg/kg)
1	1,400
5	970
7	800
11	1,700

Sample #4

SD = 0

Depth (inches)	Pb (mg/kg)
1	2,500
5	500
7	340
11	16

Sample #6

SD = 1.5

Depth (inches)	Pb (mg/kg)
1	420
5	1,900
7	270
11	32

Sample #8

SD = 0

Depth (inches)	Pb (mg/kg)
1	860
5	23
7	22
11	19

Sample #9

SD = 0

Depth (inches)	Pb (mg/kg)
1	1,933
5	1,773
7	3,700
11	2,906

Sample #10

SD = 0

Depth (inches)	Pb (mg/kg)
1	3,300
5	6,300
7	6,000
11	6,900

Sample #3

SD = 0.5

Depth (inches)	Pb (mg/kg)
1	85
5	11
7	5.8
11	13

Sample #1

SD = 3.5

Depth (inches)	Pb (mg/kg)
1	910
5	320
7	630
11	480

Deep Core #1

Depth (feet)	Pb (mg/kg)
2.5	4.6
6.7	4.0

Sample #5

SD = 0

Depth (inches)	Pb (mg/kg)
1	1,900
5	8.3
7	18
11	120

Sample #7

SD = 0

Depth (inches)	Pb (mg/kg)
1	1,000
5	24
7	160
11	12

SD = Sand depth (inches)

NO.	REVISIONS	BY	DATE
4	REVISED ANAL. RESULTS	RBL	5/10/94
3	SAND DEPTHS	RBL	4/27/94
2	SOIL CORE ANAL. RESULTS	RBL	4/26/94
1	REMOVAL ACTION WORK PLAN	MJR	3/30/94

CONTRACT NO. N/A

CAD FILE GGSS.DWG

APPROVED BY

DATE

DRAWN BY RBL

CHECKED BY PMH

SCALE 1" = 100'

GOLDEN GATE BRIDGE, HIGHWAY AND TRANSPORTATION DISTRICT

FIGURE 4-1. SOIL CORE ANALYTICAL RESULTS SOUTH APPROACH

LEAD CLEANUP PROJECT

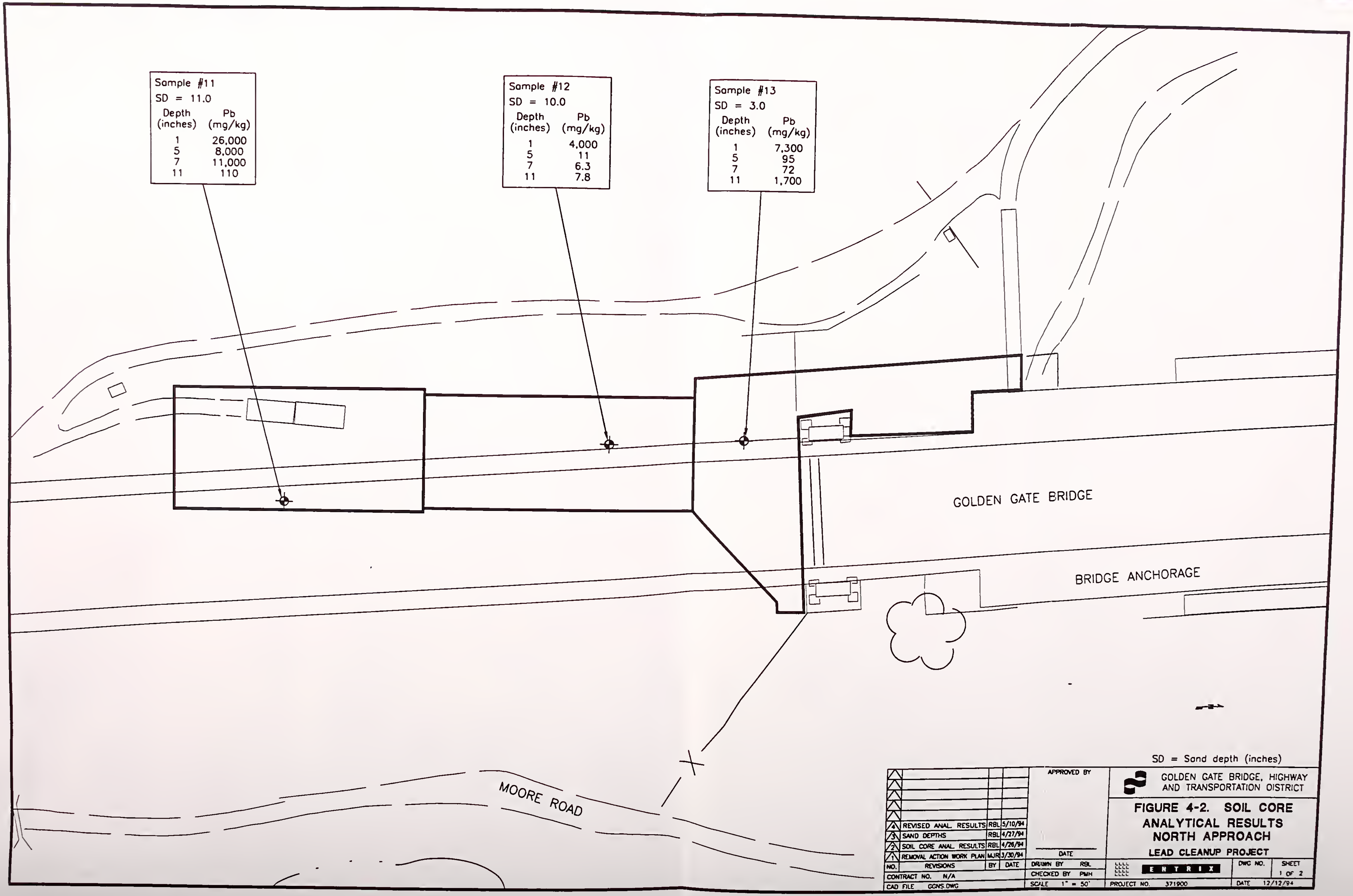
ENTRIX

PROJECT NO. 371900

DWG NO.

SHEET 1 OF 1

DATE 12/12/94



Sample #11
SD = 11.0

Depth (inches)	Pb (mg/kg)
1	26,000
5	8,000
7	11,000
11	110

Sample #12
SD = 10.0

Depth (inches)	Pb (mg/kg)
1	4,000
5	11
7	6.3
11	7.8

Sample #13
SD = 3.0

Depth (inches)	Pb (mg/kg)
1	7,300
5	95
7	72
11	1,700

SD = Sand depth (inches)

NO.	REVISIONS	BY	DATE
4	REVISED ANAL. RESULTS	RBL	5/10/94
3	SAND DEPTHS	RBL	4/27/94
2	SOIL CORE ANAL. RESULTS	RBL	4/26/94
1	REMOVAL ACTION WORK PLAN	MJR	3/30/94

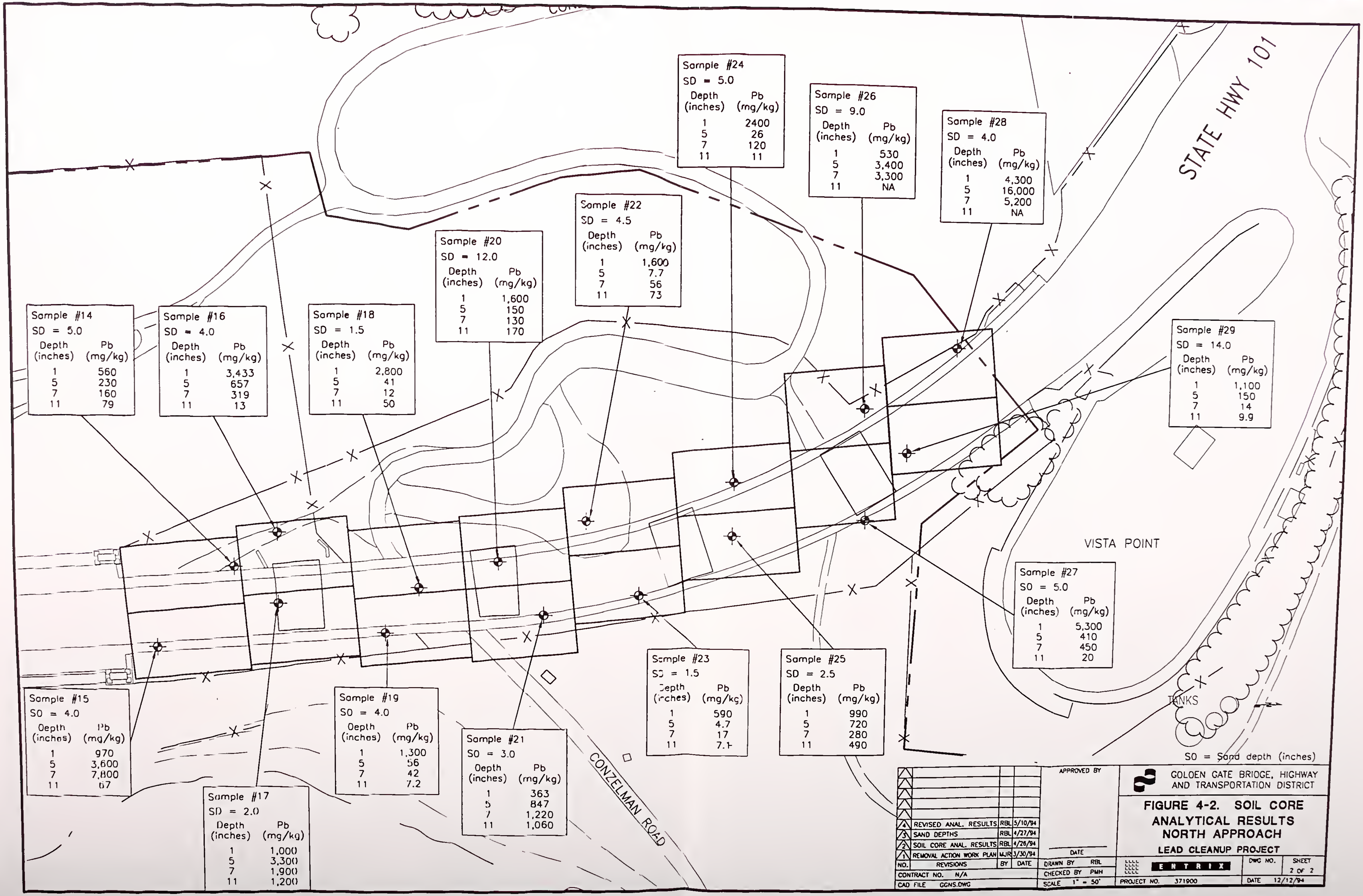
CONTRACT NO. N/A
CAD FILE GGNS.DWG

APPROVED BY
DATE
DRAWN BY RBL
CHECKED BY PMH
SCALE 1" = 50'

GOLDEN GATE BRIDGE, HIGHWAY
AND TRANSPORTATION DISTRICT

FIGURE 4-2. SOIL CORE ANALYTICAL RESULTS NORTH APPROACH
LEAD CLEANUP PROJECT

ENTRIX
PROJECT NO. 371900
DWG NO.
SHEET 1 OF 2
DATE 12/12/94



Sample #14
SD = 5.0

Depth (inches)	Pb (mg/kg)
1	560
5	230
7	160
11	79

Sample #15
S0 = 4.0

0epth (inches)	Pb (mg/kg)
1	970
5	3,600
7	7,800
11	67

Sample #16
SD = 4.0

Depth (inches)	Pb (mg/kg)
1	3,433
5	657
7	319
11	13

Sample #17
SD = 2.0

Depth (inches)	Pb (mg/kg)
1	1,000
5	3,300
7	1,900
11	1,200

Sample #18
SD = 1.5

Depth (inches)	Pb (mg/kg)
1	2,800
5	41
7	12
11	50

Sample #19
S0 = 4.0

0epth (inches)	Pb (mg/kg)
1	1,300
5	56
7	42
11	7.2

Sample #20
SD = 12.0

Depth (inches)	Pb (mg/kg)
1	1,600
5	150
7	130
11	170

Sample #21
S0 = 3.0

0epth (inches)	Pb (mg/kg)
1	363
5	847
7	1,220
11	1,060

Sample #22
SD = 4.5

Depth (inches)	Pb (mg/kg)
1	1,600
5	7.7
7	56
11	73

Sample #23
SD = 1.5

Depth (inches)	Pb (mg/kg)
1	590
5	4.7
7	17
11	7.1

Sample #24
SD = 5.0

Depth (inches)	Pb (mg/kg)
1	2400
5	26
7	120
11	11

Sample #25
SD = 2.5

Depth (inches)	Pb (mg/kg)
1	990
5	720
7	280
11	490

Sample #26
SD = 9.0

Depth (inches)	Pb (mg/kg)
1	530
5	3,400
7	3,300
11	NA

Sample #27
S0 = 5.0

Depth (inches)	Pb (mg/kg)
1	5,300
5	410
7	450
11	20

Sample #28
SD = 4.0

Depth (inches)	Pb (mg/kg)
1	4,300
5	16,000
7	5,200
11	NA

Sample #29
SD = 14.0

Depth (inches)	Pb (mg/kg)
1	1,100
5	150
7	14
11	9.9

S0 = Sand depth (inches)

NO.	REVISIONS	BY	DATE
4	REVISED ANAL. RESULTS	RBL	5/10/94
3	SAND DEPTHS	RBL	4/27/94
2	SOIL CORE ANAL. RESULTS	RBL	4/26/94
1	REMOVAL ACTION WORK PLAN	MJR	3/30/94

CONTRACT NO. N/A
CAD FILE GGNS.DWG

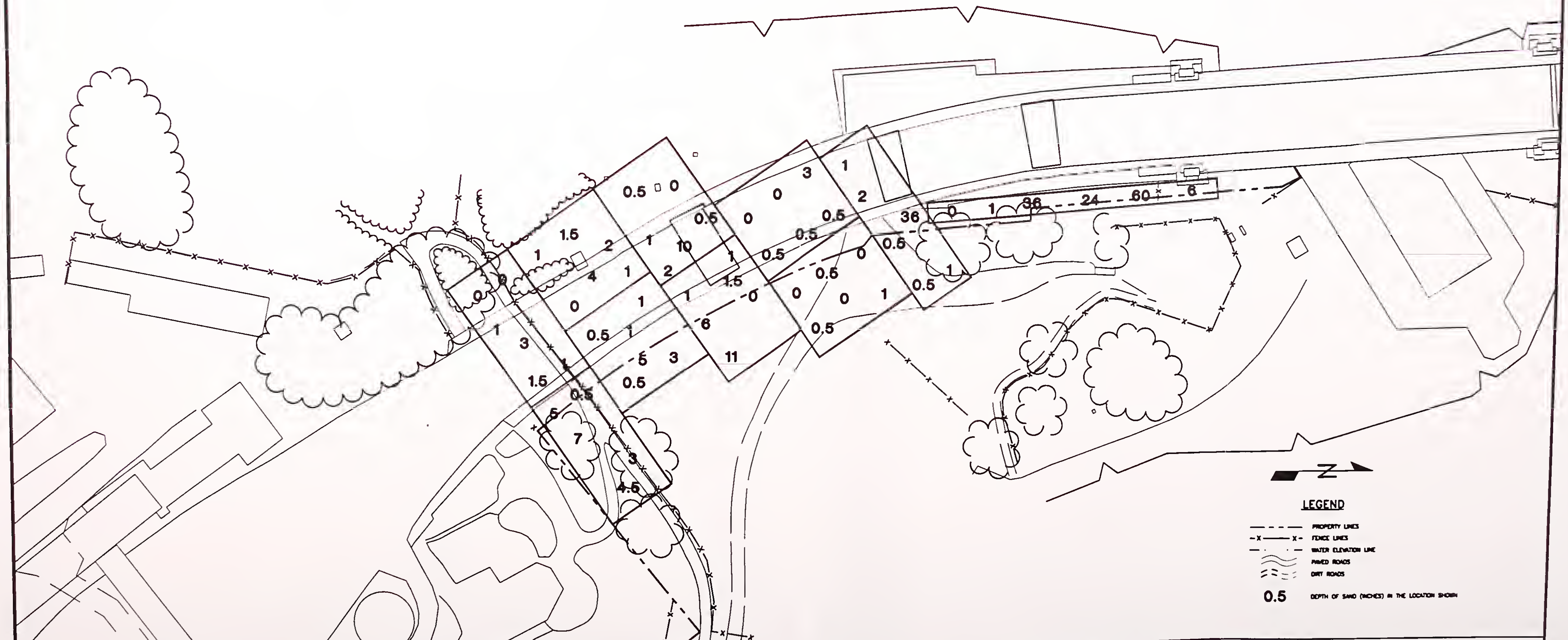
APPROVED BY
DATE
DRAWN BY RBL
CHECKED BY PMH
SCALE 1" = 50'

GOLOEN GATE BRIOGE, HIGHWAY AND TRANSPORTATION DISTRICT

FIGURE 4-2. SOIL CORE ANALYTICAL RESULTS NORTH APPROACH

LEAD CLEANUP PROJECT

ENTRIX
PROJECT NO. 371900
DWG NO.
SHEET 2 OF 2
DATE 12/12/94



NO.	REVISIONS	BY	DATE
2	SAND DEPTHS	RBL	5/10/94
1	REMOVAL ACTION WORK PLAN	MJR	3/30/94

CONTRACT NO. N/A

CAD FILE GGSS.DWG

APPROVED BY

DATE

DRAWN BY RBL

CHECKED BY PMH

SCALE 1" = 100'

GOLDEN GATE BRIDGE, HIGHWAY
AND TRANSPORTATION DISTRICT

FIGURE 4-3

SAND DEPTH MEASUREMENTS
SOUTH APPROACH

LEAD CLEANUP PROJECT

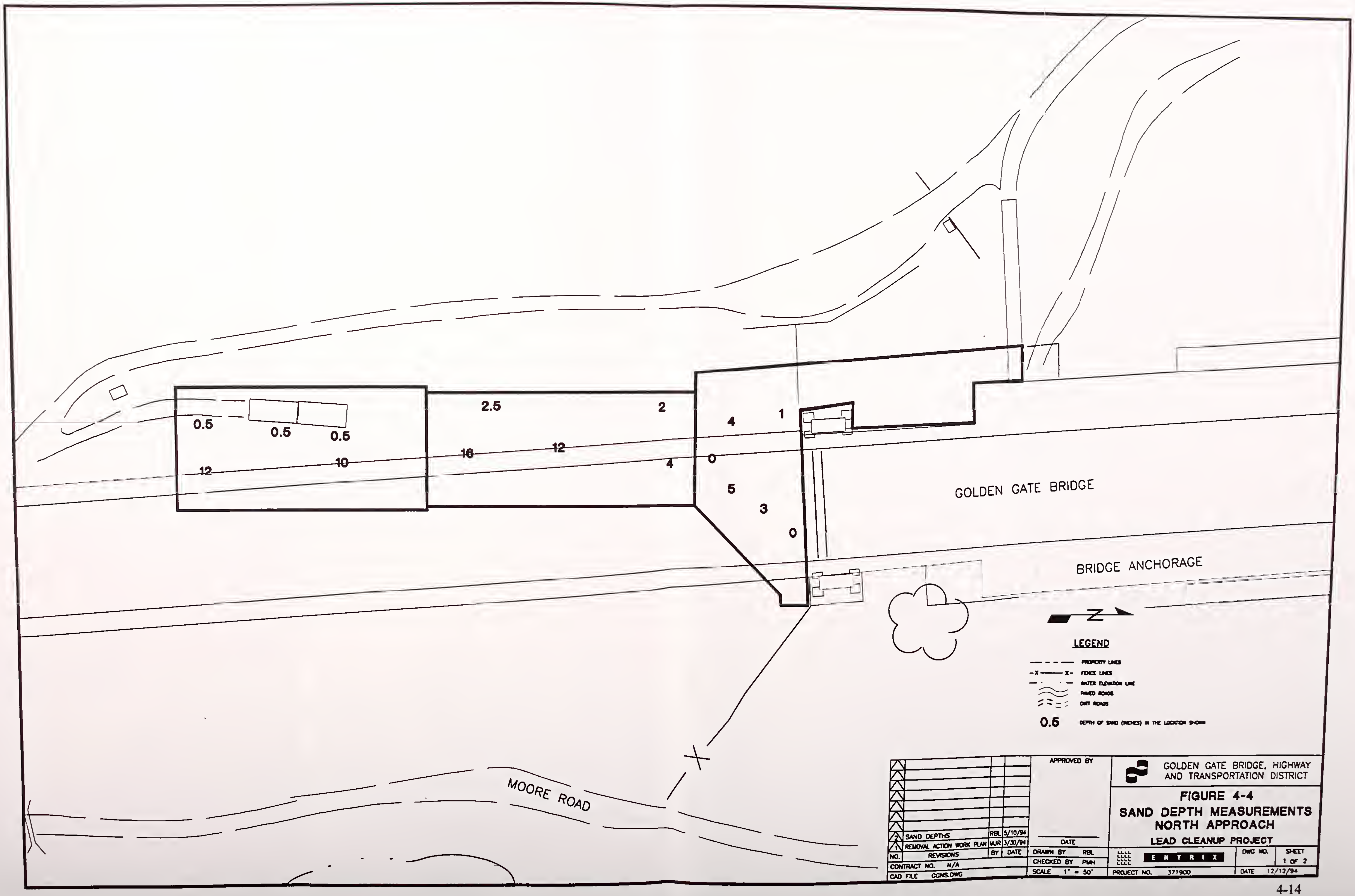
ENTRIX

DWG NO.

SHEET 1 OF 1

PROJECT NO. 371900

DATE 12/12/94



NO.	REVISIONS	BY	DATE
2	SAND DEPTHS	RBL	5/10/94
1	REMOVAL ACTION WORK PLAN	MJR	3/30/94

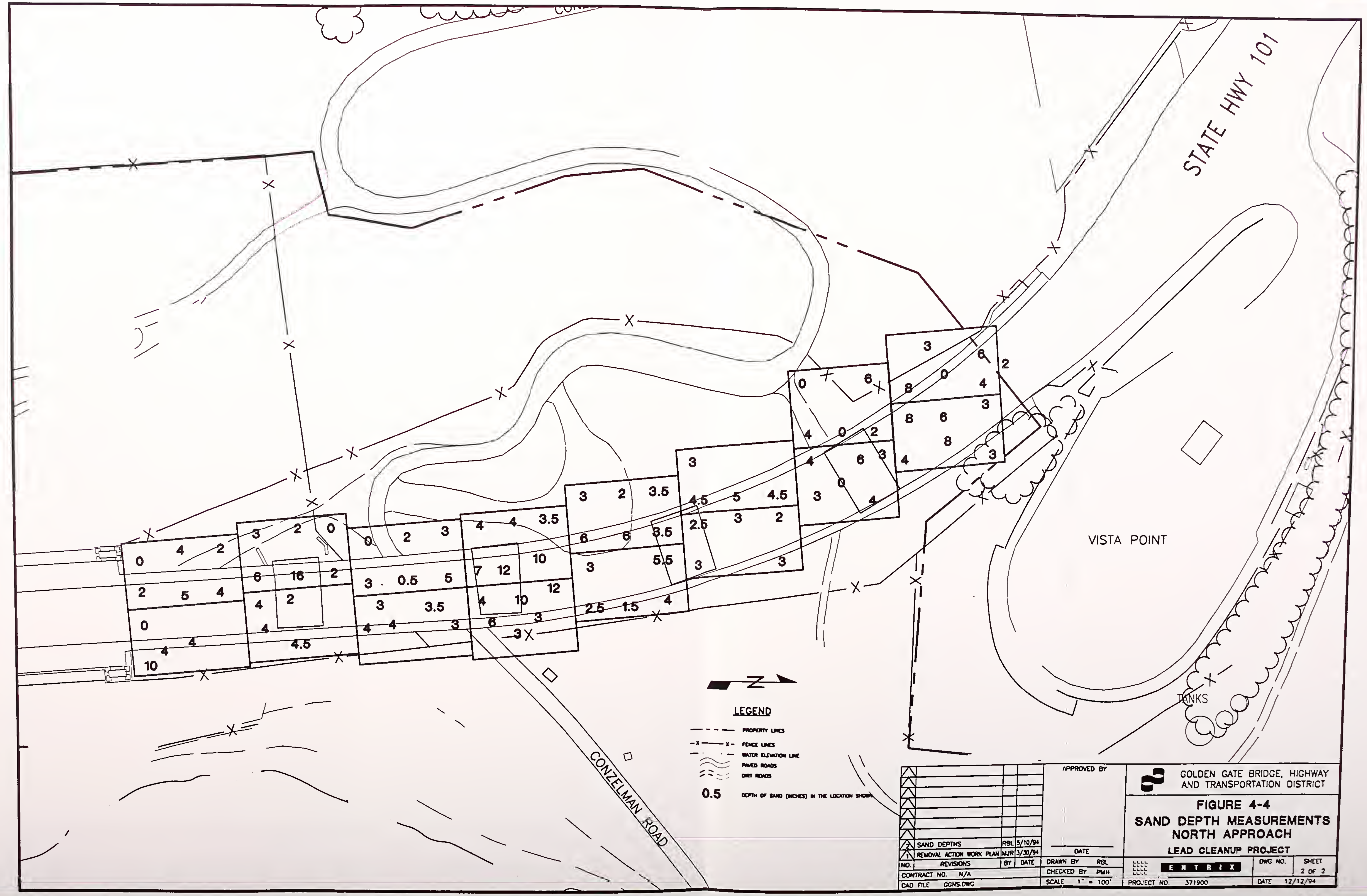
CONTRACT NO. N/A
CAD FILE GGNS.DWG

APPROVED BY
DATE
DRAWN BY RBL
CHECKED BY PMH
SCALE 1" = 50'

GOLDEN GATE BRIDGE, HIGHWAY
AND TRANSPORTATION DISTRICT

FIGURE 4-4
SAND DEPTH MEASUREMENTS
NORTH APPROACH
LEAD CLEANUP PROJECT

ENTRIX
PROJECT NO. 371900
DWG NO.
SHEET 1 OF 2
DATE 12/12/94



NO.	REVISIONS	BY	DATE
2	SAND DEPTHS	RBL	5/10/94
1	REMOVAL ACTION WORK PLAN	MJR	3/30/94

CONTRACT NO. N/A
CAD FILE GGNS.DWG

APPROVED BY

DATE

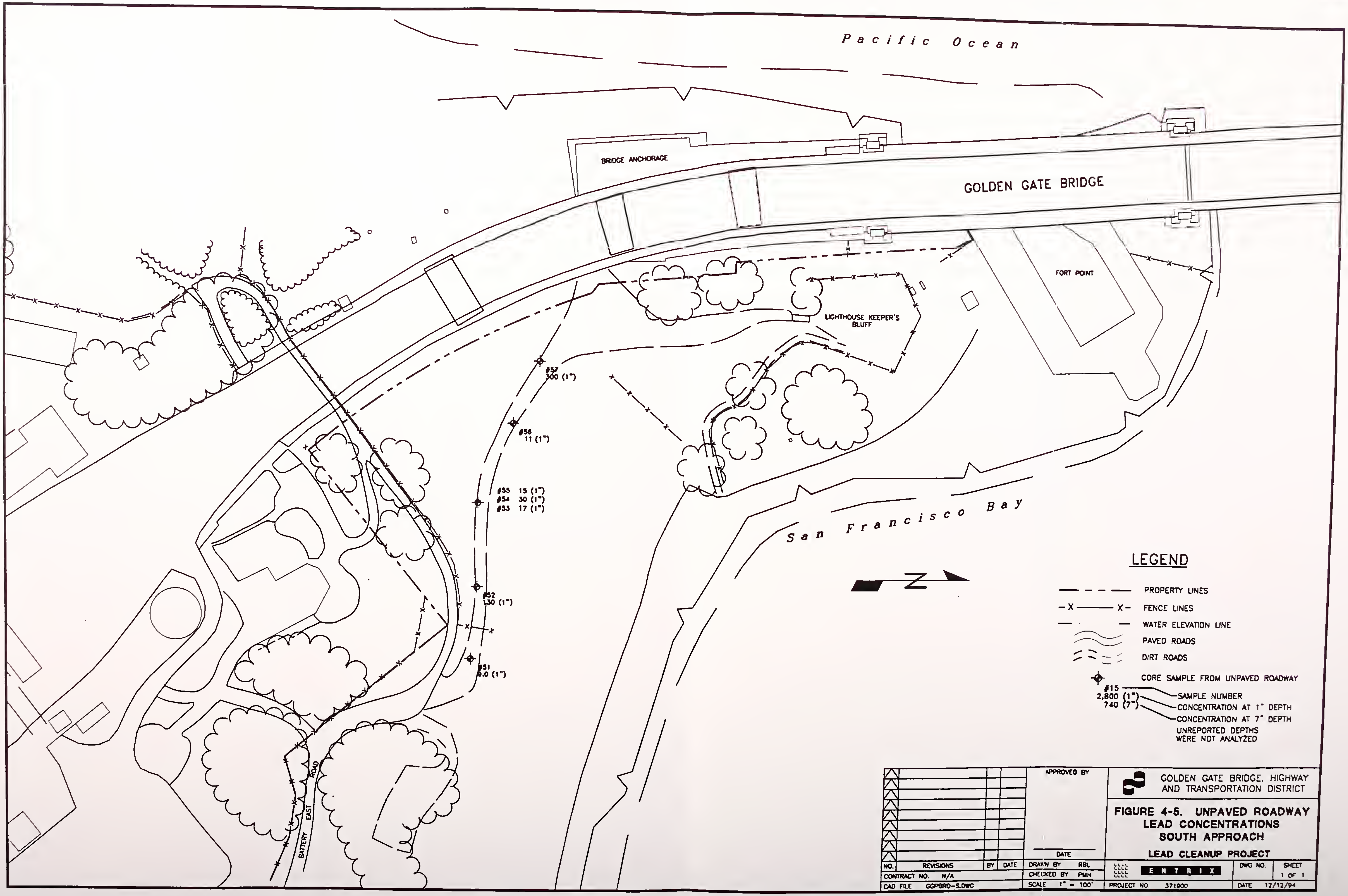
DRAWN BY RBL
CHECKED BY PMH
SCALE 1" = 100'

GOLDEN GATE BRIDGE, HIGHWAY
AND TRANSPORTATION DISTRICT

FIGURE 4-4
SAND DEPTH MEASUREMENTS NORTH APPROACH
LEAD CLEANUP PROJECT

ENTRIX

DWG NO.
SHEET 2 OF 2
PROJECT NO. 371900
DATE 12/12/94

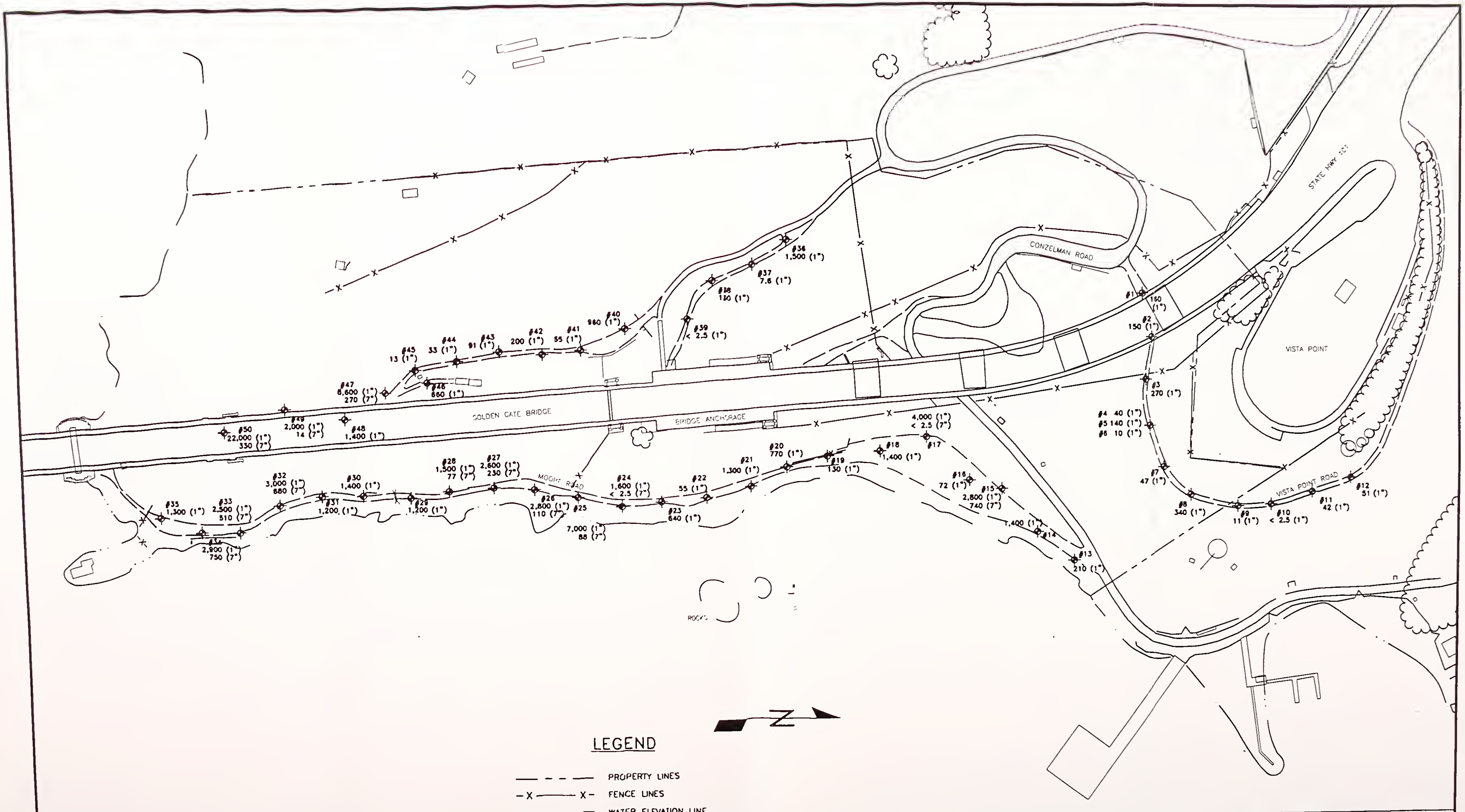


GOLDEN GATE BRIDGE, HIGHWAY AND TRANSPORTATION DISTRICT

FIGURE 4-5. UNPAVED ROADWAY LEAD CONCENTRATIONS SOUTH APPROACH

LEAD CLEANUP PROJECT

NO.	REVISIONS	BY	DATE	APPROVED BY	
				DATE	
CONTRACT NO. N/A				DRAWN BY RBL	ENTRIX
CAD FILE GGPBRD-S.DWG				CHECKED BY PMH	DWG NO.
				SCALE 1" = 100'	SHEET 1 OF 1
				PROJECT NO. 371900	DATE 12/12/94



LEGEND

PROPERTY LINES
FENCE LINES
WATER ELEVATION LINE
PAVED ROADS
DIRT ROADS
CORE SAMPLE FROM UNPAVED ROADWAY

#15 — SAMPLE NUMBER
2,800 (1") — CONCENTRATION AT 1" DEPTH
740 (7") — CONCENTRATION AT 7" DEPTH
UNREPORTED DEPTHS WERE NOT ANALYZED

NO.	REVISIONS	BY	DATE
CONTRACT NO. N/A			
CAD FILE GGPBRD-N.DWG			

APPROVED BY

DATE

DRAWN BY RBL
CHECKED BY PMH
SCALE 1" = 200'

GOLDEN GATE BRIDGE, HIGHWAY
AND TRANSPORTATION DISTRICT

FIGURE 4-6. UNPAVED ROADWAY
LEAD CONCENTRATIONS
NORTH APPROACH

LEAD CLEANUP PROJECT

ENTRIX

PROJECT NO. 371900
DWG NO.
SHEET 1 OF 1
DATE 12/12/94

5.1 ASSESSMENT OF CURRENT AND POTENTIAL RISKS

A human health risk assessment (HRA) has been completed, a technical report reviewed, and results approved by DTSC to determine acceptable cleanup levels. Visitor use patterns developed by the GGNRA and Seismic Retrofit Project environmental assessment documents were used to develop public exposure scenarios. An ecological risk assessment will be performed as part of Phase II Lead Cleanup Project.

A site specific acceptable level of lead in soil was developed using the DTSC Lead Risk Assessment Spreadsheet, Version Pb6, known as "Leadspread Pb6." Model input parameters were developed for various site specific exposure scenarios. Using those parameters, Leadspread Pb6 calculated a site specific health risk based cleanup level of 1,396 mg Pb/kg soil. DTSC has approved the site specific exposure scenarios, model input parameters, and resultant cleanup level for use in Phase I of the Lead Cleanup Project.

The acceptable risk-based remediation concentration is based on potential effects to blood lead concentrations. The risk assessment was performed according to the following documents and databases.

- California Environmental Protection Agency (CAL EPA). 1992. Supplemental Guidance for Human Health Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities. DTSC, Office of the Science Advisor, July.

- U.S. Environmental Protection Agency (EPA). 1989. Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, Part A, Interim Final, EPA/540/1-89/002, December.

- EPA . 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors" OSWER Directive 9285.6-03.

- EPA. 1988. Superfund Exposure Assessment Manual, EPA/540/1-88/001, April.

- EPA. Integrated Risk Information System (IRIS).

The risk assessment included the following tasks:

Conceptual Model of the Site

A conceptual model of the site was developed based on physical descriptions of the land, land use and receptor-activity analyses. The model described the conceptual basis for the potential exposure pathways that were quantified for risk assessment. Activity analysis information was obtained from ESA, discussions with GGBH&TD personnel and community members.

Chemical Transport

A general description of the fate and transport of lead was prepared. This information was integrated with site-specific information to lend support for the conceptual model in describing potential exposure pathways.

Toxicology of Lead

Primary routes of exposure to lead are ingestion and inhalation. Dermal uptake of inorganic lead is relatively unimportant compared to ingestion and inhalation. In most toxicological discussions of lead exposure, dermal absorption is omitted.

Lead is responsible for a variety of toxicological effects. It is classified by the U.S. EPA as a Group B2, probable human carcinogen based on inadequate evidence for carcinogenicity to humans and sufficient evidence for carcinogenicity to animals. In

1988, the U.S. EPA recommended that numerical estimates of cancer potency and risk not be undertaken due to the uncertainty involved in the estimates. The variety and unusual range of toxicity associated with lead accounts for the recommendation. Instead, pharmacokinetic effects to blood lead concentrations in humans are quantitatively evaluated when investigating potential adverse health effects. This approach was followed during the performance of this evaluation. A blood level concentration of 10 µg Pb/dl blood was used as the reference criterion, in accordance with guidance documents from both U.S. EPA and Cal EPA, for evaluating potential adverse health effects due to lead concentrations in soil.

EXPOSURE ASSESSMENT

Exposure pathways considered in the HRA consist of four elements:

1. A source and mechanism of chemical release to the environment.
2. Environmental transport and fate processes for each medium for the released chemical.
3. A point of potential contact to humans or biota with the contaminated medium (the exposure point).
4. An exposure route at the exposure point

The HRA discusses the transport and fate of lead within each medium and identify site-specific factors affecting current potential exposures. The list of potential routes of exposure considered in the HRA follow:

- Incidental soil and dust ingestion
- Dermal contact
- Inhalation of airborne chemical-affected dust
- Ingestion of water

- Dietary intake

Since most human health effects due to lead exposures are evaluated based on blood lead concentrations, the task of calculating cleanup goals was based on potential exposures and their effects on blood lead levels. Exposure was quantified using Cal EPA's Leadspread Pb6. The identification of potential human receptors is based on an evaluation of the site activity analysis (ESA, August 1994) and talks with GGBH&TD personnel and community members. The following potential receptors were identified:

- Average out of town visitor
- Average Bay Area resident visitor
- Special interest group users
- Joggers
- Recreational bicycle riders
- Children who use the areas in question as part of their play areas (e.g., Fort Baker)
- Fishing (from the shoreline or piers)
- Fort Point Visitors
- Commuters over the Bridge
- Surfers along Fort Point
- Red and White Ferry Tours
- Incidental pleasure boating and commercial shipping
- Party boat fishing

- Workers at Fort Point (GGNRA)

- Workers at the Bridge (retrofit construction, maintenance, toll takers and administrative)

- Workers at Fort Baker (GGNRA, the grounds keepers, etc.)

The receptors were evaluated relative to exposure to lead in soil and sand on land near the Bridge. The various use scenarios were reduced to five specific scenarios for detailed analysis. The five scenarios that were identified as representative of the exposures at the site included:

- a seismic retrofit worker;

- a GGNRA groundskeeper responsible for landscape maintenance adjacent to bridge approaches;

- a jogger who runs through the site on a normal basis;

- a child who plays on-site on a routine basis; and

- a fisherman who fishes along the shoreline beneath the bridge.

CONCEPTUAL APPROACH

It is assumed that current and past use of the site will continue into the future. The Phase I areas of the site are not used for residential purposes and there are no plans for residential development in the future. Therefore, occupational and recreational exposures are the current and future potential exposures of concern associated with the site. If necessary, restrictions could be placed on the use of the Phase I areas of the site to strengthen the non-residential assumption. Under occupational or recreational potential exposure scenarios, an individual is assumed to reside elsewhere off-site and come on-site to engage in various types of occupational or recreational activities. This assumption requires consideration of two different sources of potential exposure to lead: occupational or recreational exposures occurring on-site and background residential exposures off-site. Quantification of blood lead from these two sources are made in the formulas in the Leadspread Pb6 model.

CALCULATION OF CLEANUP GOALS

The calculation of cleanup goals was performed by completing an iterative series of modeling exercises with Cal EPA's Leadspread Pb6 model. Calibration of the model was performed in the exposure assessment. The purpose in this phase of the evaluation is to optimize the relationship between blood lead concentrations that will not exceed a reference toxicity criterion of 10 µg/dl as the maximum acceptable blood lead concentration.

INPUT PARAMETERS

The ambient lead concentration in air was a value obtained from the Bay Area Air Quality Management District (BAAQMD). Ms. Lucia Libretti, Public Information Officer, stated that the concentration of lead in ambient air in the Bay Area is one-thirtieth of the air quality standard for lead in air. The standard is 1.5 ug/m^3 and the measured monthly average for lead in the Bay Area is less than 0.05 ug/m^3. This value was used for the ambient air concentration of lead.

A concentration of lead in drinking water of 5 ug/l was used as the model input concentration. Several alternatives were possible. The current California Drinking Water Standard is 50 ug/l, although it is largely ignored because the federal drinking water criterion is more stringent. The federal criterion is based on an action level of 15 ug/l at the tap. Based on federal criterion, a concentration of 15 ug/l was another alternative; however, SOMA has collected random municipal water quality data from various cities in the Bay Area and this data indicates that lead concentrations in drinking water at the source is typically less than 5 ug/l. In addition, SOMA has a limited number of tap samples which have been analyzed for lead. Sample analytical results are typically less than 5 ug/l.

The plant uptake and ingestion of home-grown crops was not evaluated because the site is not presently used for residential use, nor are there future plans for residential development. The ingestion of home-grown crops are not a source of lead uptake at the site. The ingestion of berries and other edible vegetation by GGNRA groundskeepers during their work was considered.

A value of 50 μg/m^3 was used for airborne dust levels. This value is the National Ambient Air Quality Standard for PM10. PM10 is a fractional description of dust that refers to dust particles equal to or less than 10 microns in diameter.

In order to include an evaluation of background exposures, an additional input parameter was added representing off-site background concentrations of lead in soil of 30 μg/g. The value is above the geometric mean concentration of lead in soil in the western United States of 18 μg/g (Connor and Shacklette, 1975). The 30 μg/g was used as it is believed to reflect background levels of lead in soil found at the Presidio, as reported by GGNRA.

RESULTS AND UNCERTAINTY ANALYSIS

The HRA has resulted in a lead cleanup level, protective of human health for the given receptor population of 1396 mg Pb/kg soil. The seismic retrofit worker is the receptor whose exposure is limiting and sets the cleanup level.

The model ranked the five exposure scenarios as follows, in order from most exposed to least exposed, as indicated by blood lead levels if the lead in soil concentration is 1396 mg/kg:

- a seismic retrofit worker;
- a GGNRA groundskeeper responsible for landscape maintenance adjacent to bridge approaches;
- a child who plays on-site on a routine basis;
- a jogger who runs through the site on a normal basis; and
- a fisherman who fishes along the shoreline beneath the bridge.

The risk assessment methodology is conservative, as described below. Further, the following conditions will apply after the Phase I remedial action implementation.

- Visible accumulations of sand will have been removed, leaving native soil.
- Seismic retrofit work will be performed under dust controls to minimize on-site and off-site dust migration.
- Seismic retrofit construction areas will be accessed via construction entries designed to remove soil from vehicle tires.

These actions are designed to limit transport of and exposure to residual contaminants after the Phase I remedial action occurs.

The assumptions, procedures, and parameters used in the risk assessment process were subject to various degrees of uncertainty. Uncertainty analysis provides an understanding of the limitations in the interpretation of the quantitative process presented in the report.

A general principle of exposure assessment is that conservative assumptions (i.e., assumptions that tend to overestimate exposure and therefore risk) are made at each step, so that the final estimates of exposure will be higher than (often much higher than) the upper end of the likely range of actual exposures. Estimates of exposure developed in the risk assessment are conservative, in this sense, in two ways.

First, for each exposure scenario, the sub-populations likely to be most exposed (for example, residents in the house located closest to the area of concern) is considered. For this reason, the estimates of exposure are really only valid for the most highly exposed persons, referred to as the maximally exposed individual (MEI) and will overestimate exposure for most people. Estimates of the reasonable maximum exposure (RME) and average exposed individual (AEI) provide perspective in the MEI estimate of risk, although the exposure assumptions in evaluating both the RME and AEI are conservative and tend to overestimate the risk.

Second, exposure assessments for these persons incorporate conservative assumptions about many factors that influence exposure, including emission rates, deposition rates, environmental persistence, bio-uptake, bioavailability, and human activity. For this reason, the exposure estimates are intended to overestimate exposures even for the MEI. The potential effect of the combination of generally conservative assumptions compound the tendency to greatly overestimate exposure and therefore tend to lead to conservative cleanup levels (e.g., very protective).

6.0
EFFECTS OF CONTAMINATION UPON BENEFICIAL USES OF RESOURCES

6.1 PRESENT USES OF THE LAND/WATER

The present use of the site is for bridge maintenance, recreational use, and tourism. Current use of the specific Phase I areas is restricted by the fence and post order implementation. There is no present human use of surface water or groundwater in the Phase I areas.

6.2 FUTURE USES OF THE LAND/WATER

The future uses of the site will continue to be for bridge maintenance, recreational use, and tourism. The GGNRA has developed the Presidio Plan, presenting proposed changes in use of the Presidio lands. The Phase I areas will not be affected by the transfer of ownership of surrounding public land from the Army to the GGNRA or the associated Presidio Plan.

6.3 PROBABLE BENEFICIAL USES OF THE LAND/WATER

The beneficial use of the site includes access for bridge maintenance, tourism and recreation. The Phase I areas are currently fenced and posted with hazardous materials warning signs. Implementation of this Phase I RAP will allow construction access to the areas that will be used for the Seismic Retrofit Project. Public use will be available after completion of the Seismic Retrofit Project.

The groundwater at the north approach has possible beneficial use as freshwater replenishment to surface water associated with springs above the site. The confined aquifer identified above bedrock below the viaduct section of the north approach may be considered a potential source of drinking water, as defined by the RWQCB San Francisco Bay Basin Plan.

7.0
REMEDIAL ACTION FEASIBILITY STUDY

Remedial alternatives were developed through a technology screening effort. Specific remedial technologies that had potential application to the site were screened based on literature review, vendor demonstrations, or bench scale testing. Successful technologies were combined into a variety of appropriate remedial alternatives. The remedial alternatives were then screened on a preliminary basis and four final alternatives were subjected to a detailed analysis.

7.1 REMEDIAL ALTERNATIVE SELECTION PROCESS

Remedial alternatives were assembled using feasible technologies. The remedial alternatives were then screened and analyzed in accordance with the criteria identified in the NCP.

7.1.1 REMEDIAL ALTERNATIVE ANALYSIS DECISION-MAKING CRITERIA

The March 1990 NCP lists nine criteria to be considered when evaluating and selecting alternatives. These criteria are to be applied in two steps. Initially, alternatives must meet the first two "threshold" criteria in order to be considered at all. Then, the "balancing" criteria are used to rank surviving alternatives, with the greatest weight given to long-term effectiveness and permanence, and to reductions in toxicity, mobility or volume. The modifying criteria are then applied to fine tune the alternative.

SARA states that cleanup methods in which treatment "permanently and significantly reduces the volume, toxicity or mobility of... hazardous substances...are to be preferred over remedial actions not involving such treatment." SARA discourages the off-site transport and disposal of hazardous substances.

"Threshold" Criteria:

1. Overall protection of human health and the environment addresses the extent to which the remedial alternative can adequately protect human health and the environment from unacceptable risks both in the short term during implementation as well as in the long-term after implementation is complete.

2. Compliance with Applicable or Relevant and Appropriate Requirements (ARARs) addresses whether the remedial action complies with federal, state, or local ARARs.

"Balancing" Criteria:

3. Long-term effectiveness and permanence considers the probability of treatment success, the magnitude of residual risk remaining at the conclusion of remedial activities and the adequacy and reliability of controls necessary to manage any such residual risk.

4. Reduction of toxicity, mobility, or volume through treatment considers the degree to which the recycling or treatment remedial processes will reduce the toxicity, mobility, or volume of the media of concern.

5. Short-term effectiveness identifies impacts of the remedial alternative that may be posed during implementation and assesses the time required for protection to be achieved.

6. Implementability considers the technical, administrative, and logistical feasibility and availability of any services, permits, or resources required by the remedial alternative.

7. Cost addresses the required capital and the alternative's operations and maintenance costs; and the net present value of these costs.

"Modifying" Criteria:

8. State acceptance addresses the potential regulatory acceptance of the alternative. A complete assessment of regulatory agency concerns is not possible until the state review process is concluded.

9. Community acceptance addresses the potential acceptance by the community based on available public input and the anticipated public reaction to the alternative. This criterion is evaluated further during the public comment process.

These criteria have been applied in accordance with NCP guidance to select the remedial approach for this site.

7.1.2 APPROPRIATE FEDERAL, STATE, AND LOCAL GOVERNMENT REQUIREMENTS

7.1.2.1 Applicable or Relevant and Appropriate Requirements

Under California law, remedial actions must be based on the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) established pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act, as amended (CERCLA; also called Superfund), as well as state requirements. These requirements are known as Applicable or Relevant and Appropriate Requirements (ARARs). CERCLA requires that all legally enforceable ARARs be considered in the selection of remedial alternatives. Non-enforceable federal, state and local criteria and advisories, (particularly those that are health- or risk-based) may also be included as to-be considered (TBCs) requirements when determining remedial goals and assessing potential remedial alternatives for the site. California law requires that remedial actions be consistent with CERCLA requirements. ARARs are defined by the U.S. Environmental Protection Agency as follows:

- Applicable Requirements are the cleanup standards, standards of control and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, hazardous waste, pollutant, contaminant, remedial actions, location, or other circumstances at a particular site.

- Relevant and Appropriate Requirements are cleanup standards, standards of control and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not "applicable" to a hazardous substance, hazardous waste, pollutant, contaminant, remedial action, location, or other circumstance at a particular site, address problems or situations sufficiently similar to those encountered at the site that their use is well suited to the particular site.

The EPA identifies three categories of ARARs: chemical-specific, location-specific, and action-specific. TBCs can also be classified using these categories. Each of these categories are described below:

- Chemical-Specific ARARs. Chemical-specific ARARs identify health- or risk-based concentration limits for human exposure to chemicals in the environment;

- Location-Specific ARARs. Location-specific ARARs place restrictions on activities at a site due to the particular location of the site. For example, implementation of a specific remedial alternative may be restricted due to the location of the site relative to a fault or floodplain; and

- Action-Specific ARARs. Action-specific ARARs apply to specific activities such as remedial action taken for hazardous substances or wastes.

ARARs and TBCs are used to determine remedial goals and to evaluate potential remedial alternatives. Remedial goals are determined by evaluating chemical-specific ARARs and TBCs. Remedial alternatives for the site must comply with chemical-specific, location-specific, and action-specific ARARs.

The DTSC policy for the development and approval of RAPs requires, at a minimum, review of the following requirements to ensure consistency:

- California Hazardous Substances Cleanup Bond Act of 1984

- Hazardous Substance Account of 1981 (Chapter 6.8 of the California Health and Safety Code)

- California Environmental Quality Act (CEQA)

- Comprehensive Environmental Responsibility, Compensation Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA)

- Resource Conservation and Recovery Act (RCRA)

- NCP, Title 40 Code of Federal Regulations (CFR) Part 300 et seq.

CERCLA established a national program for responding to releases of hazardous substances into the environment. In addition, the NCP establishes the process for determining appropriate remedial actions at Superfund sites. The Golden Gate Bridge site is not a listed federal superfund site. Section 121 of SARA requires remedial actions to be protective of human health and the environment and comply with ARARs.

RCRA, as amended in 1984, regulates storage, transportation, treatment, and disposal of hazardous wastes.

CEQA requires the potential environmental impacts of remedial actions proposed for a site to be analyzed. Activities that have potential impact on the environment must be identified and mitigation measures proposed.

General Requirements. Other laws and regulations that might be considered as ARARs include:

- California Code of Regulations (CCR), Titles 22 and 26, provide the California criteria for defining hazardous materials and hazardous wastes and provide regulations regarding the storage, treatment, transportation, and disposal of hazardous materials and hazardous wastes.

- The Regional Water Quality Control Board (RWQCB) regulates disposal of hazardous wastes to California Class I and II landfills (Chapter 15, CCR), and sets rules and regulations regarding water discharges and water quality.

- The Integrated Waste Management Board (IWMB) regulates disposal of solid wastes to California Class III landfills.

- The Bay Area Air Quality Management District (BAAQMD) sets rules and regulations regarding air emissions and air quality.

- Federal and California Occupational Safety and Health Administration (OSHA) general industry and construction standards for hazardous waste sites are set forth in Title 29, CFR 1910 et seq., Title 29 CFR 1926 et seq., and Title 8 CCR Part 1, Chapter 4, respectively.

- California Business Code Sections 7028.1, 7058.7 and 7228.6 and California Labor Code Section 142.7 regulate remedial action contractors performing construction activities which cover contractor licensing, training, and worker safety requirements.

There is no standard health based regulation applicable to concentrations of lead in soil for this site, so the site specific health based risk assessment becomes the primary chemical and location specific TBC in determining the appropriate cleanup level for this site.

The U.S. EPA has issued *Guidance on Residential Lead Based Paint, Lead Contaminated Dust, and Lead Contaminated Soil.* This document is a chemical specific TBC applicable to this site. It suggests that, for lead in soil from 400 to 2,000 mg/kg exposure of children should be limited. For lead in soil from 2,000 to 5,000 mg/kg it recommends administrative measures to limit exposure. For lead in soil in excess of 5,000 mg/kg it recommends abatement.

7.1.2.2 Agencies with Jurisdiction over Site Activities

Agencies that may have jurisdiction over the site activities and remedial actions include:

- DTSC - The DTSC is the lead regulatory agency for the Golden Gate Bridge Lead Cleanup Project. All investigative and remedial activities have been voluntary but subject to DTSC's supervision and approval.

- CalTrans - is the administering agency for federal funds for the Seismic Retrofit Project, as an agent for the Federal Highways Administration, and as such is overseeing the detailed design of the entire Seismic Retrofit Project, including review of designs for Phase I of the Lead Cleanup Project.

- Federal Highways Administration (FHA) administers the funding for federal highway projects such as the Seismic Retrofit Project. They use CalTrans as their agent to oversee federally funded projects in California.

- RWQCB - Regulates disposal to Class I and II landfills within California; reviews and approves stormwater discharge permits for construction sites.

- BCDC - Regulates excavation, fill, and construction activities within 100 feet of the high tide line.

- Integrated Waste Management Board (IWMB) - Regulates disposal to Class III landfills within California.

- BAAQMD - Regulates air emissions which may be generated during soil excavation and grading.

- GGNRA - Permits soil excavations, grading, and demolition within GGNRA boundaries.

7.1.3 REMEDIAL ACTION OBJECTIVES

Remedial Action Objectives are media-specific goals for protecting human health and the environment. Remedial Action Objectives establish the chemicals of concern, media, receptors, and cleanup goals for each exposure pathway. Cleanup goals are developed to direct remediation toward adequately protecting public health and the environment. The human health risk assessment found that potential risks posed by exposure to lead in soil on-site are primarily based on the potential for uptake through ingestion and inhalation. The purpose of the remedial action at the site is to prevent chemical uptake at levels conservatively predicted to pose a potential health risk via these and other exposure pathways. Accordingly the Remedial Action Objectives are:

- prevent ingestion and direct contact with soil that contains lead in excess of the human health risk based cleanup level of 1396 mg Pb/kg soil;

- prevent inhalation of airborne soil particulates and lead generated from remediation and seismic retrofit work in areas that contain lead in excess of the human health risk based cleanup level;

- reduce exposure pathways for lead by removal or treatment of lead in soil based on the human health risk based cleanup level established for the site.

Zinc is another contaminant of concern at the site. Existing on-site concentrations appear to be well below the EPA Preliminary Reduction Goal (PRG) of 100,000 mg zinc/kg soil for industrial sites and the more conservative PRG for residential sites of 23,000 mg zinc/kg soil. 5,000 mg zinc/kg soil is arbitrarily selected as the basis of a secondary Remedial Action Objective:

- reduce exposure pathways for zinc by removal or treatment of zinc in soil to a level of 5,000 mg zinc/kg soil.

7.2 TECHNOLOGY SCREENING

The initial technology screening is presented on attached Table 7-1. Ten treatment technologies were identified and evaluated. In addition, three supplemental technologies were identified for use in combination with the various treatment technologies.

The technologies were evaluated based on available technical literature, vendor bench tests, and/or on-site demonstrations. Technically feasible technologies were then retained and assembled into twelve remedial alternatives, identified as alternatives A through L. The no action alternative was added, in accordance with regulatory guidance, as alternative M. The preliminary remedial alternatives are listed in Table 7-2.

7.3 PRELIMINARY REMEDIAL ALTERNATIVE SCREENING

Each preliminary remedial alternative (Alternatives A through M) is described in this section.

Remedial alternatives A through M were subjected to a preliminary screening. Alternatives that were not in compliance with applicable or relevant and appropriate requirements (ARARs) or were not protective of human health and the environment, or were not feasible for the site for other reasons, were rejected. Table 7-3, Preliminary Remedial Alternative Screening, presents the screening summary.

7.3.1 ALTERNATIVE A: FIXATION OF MATERIAL WITHIN SR FOUNDATION CONCRETE

Contaminated material would be removed from Phase I areas, for blending into concrete. Incorporation of the contaminated material into concrete to be used for new foundation work in the SR project would be subject to strict material requirements, and would require extensive screening to remove vegetation and debris. The logistics of mixing location, timing, and stockpiling of the contaminated material is unknown. Due to the critical nature of the foundation work, associated risk of impacting the structural integrity of the bridge and thereby endangering public safety and health, as well as difficult logistics, this alternative was not selected.

Table 7-1. Technology Screening Summary.

Treatment Technology	Technology Screening	Remedial Alternative
1. Chemical fixation	passed TCLP	a. blend into cement ex situ for SR foundations b. blend into cement ex situ for fill in bridge structures c. fix ex situ and use for SR structured backfill d. fix in situ e. fix ex situ and use as roadbase under an asphalt cap
2. Acid leaching	reduced total lead below cleanup goal	f. treat ex situ, send lead to off-site recycle, return soil to site g. treat ex situ, send lead to off-site recycle, manage soil as fill on-site
3. Asphalt encapsulation	feasible	h. remove material to off-site asphalt plant for treatment
4. Resin encapsulation	feasible	i. collect material onto site roads, pretreat with resin and cap with asphalt j. treat roads in situ, remove and treat other material on-site for use as structured backfill
5. Landfill disposal	feasible	k. remove material and dispose off-site
6. Lead smelting	passed facility acceptance, accepts sand only	l. vacuum sand, send to smelter, remove and treat soil on-site
7. Froth flotation/Soil washing	marginal results	retain for consideration in conjunction with other technologies
8. Air density separation	failed bench test	
9. Electrochemical removal	rejected, unproven	
10. Magnetic separation	failed bench test	
Supplemental Technology	**Technology Screening**	**Technology Assessment**
11. Vacuum removal	successful field demo	use in all removal alternatives in areas with no other access, use where separation of sand and soil is desirable
12. Capping	feasible	use in other alternatives as appropriate
13. XRF technology	preliminary field demo passed	use in all alternatives as a real time analytical tool, with back up confirmation by standard analytical methods

Table 7-2. Preliminary Remedial Alternatives.

A. Fixation of material within SR foundation concrete

B. Fixation of material in concrete placed as fill within bridge structures

C. Ex situ chemical fixation, on-site use as structured backfill

D. In situ chemical fixation

E. Ex situ chemical fixation, on-site use as roadbase under an asphalt cap

F. Ex situ acid leaching, recycle lead off-site, return cleaned soil to surface

G. Ex situ acid leaching, recycle lead off-site, use cleaned soil as structured backfill

H. Remove material to recycle at an off-site asphalt plant

I. Ex situ encapsulation with resin, use as roadbase under an asphalt cap

J. Encapsulate roads in situ, encapsulate other areas ex situ for use as structured fill

K. Remove material to an off-site landfill

L. Vacuum sand, recycle off-site via lead smelting

M. No action

Table 7-3. Preliminary Remedial Alternative Screening.

Remedial Alternative	Description	Protective of Human Health and Environment?	Compliant with ARARs?	Rationale for Rejection of Alternatives
A	blend into cement in SR foundations	N	Y	May jeopardize the structural integrity of the foundations of bridge structures.
B	blend into cement in bridge structures	N	Y	Will limit access to interiors of structures for inspection, maintenance, and repair.
C	fix and use as structured backfill	Y	Y	**Retained for detailed analysis.**
D	fix in situ	N	N	Total lead levels would remain, allowing potential exposure to seismic retrofit workers, not in compliance with human health based cleanup level.
E	fix for use as roadbase below asphalt	Y	Y	**Retained for detailed analysis.**
F	acid leach, recycle lead, return soil	Y	Y	**Retained for detailed analysis.**
G	acid leach, recycle lead, backfill soil	Y	Y	**Retained for detailed analysis.**
H	remove to off-site asphalt plant	Y	N	Off-site asphaltic emulsion encapsulation is not permitted for federal RCRA wastes, so most of the material removed from this site cannot be treated in this manner.
I	encapsulate for use as roadbase, asphalt cap	Y	Y	Same on all criteria as alternative E, but more expensive.
J	encapsulate for use as backfill	Y	Y	Same on all criteria as alternative C, but more expensive.
K	off-site disposal	Y	Y	SARA discourages off-site transport and disposal; most expensive.
L	sand to smelter, treat soil on-site	Y	Y	The lead smelter sand capacity is limited, undesirable long term stockpile of untreated sand would be required.
M	no action	N	N	**Retained for detailed analysis.**

7.3.2 ALTERNATIVE B: FIXATION OF MATERIAL IN CONCRETE PLACED AS FILL WITHIN BRIDGE STRUCTURES

Contaminated material would be removed from Phase I areas, for blending into concrete. The use of the contaminated material in a cement matrix, as fill in bridge pylons and anchorage housings, may enhance the strength of those structures. The specific quantity of material that the structures could accept is unknown, but is expected to be limited to a fraction of the material available. The material would have to be stockpiled until the SR project activities at the pylons and anchorage housings are complete. Potential impact on future bridge maintenance access may occur, resulting in risk to the structural integrity of the bridge and thereby endangering public health and safety, so this alternative was not selected.

7.3.3 ALTERNATIVE C: EX SITU CHEMICAL FIXATION, ON-SITE USE AS STRUCTURED BACKFILL

Contaminated material will be removed from Phase I areas for treatment and use as fill on-site. The use of the contaminated material as backfill in SR project excavations, in lieu of replacing the excavated soil, will require prior treatment to enhance structural characteristics and immobilize the lead. The contaminated material may be pre-treated by a physical separation method to reduce the volume of material that is subsequently treated by chemical fixation. Chemical fixation is a process that chemically binds contaminants in an insoluble form. Additives such as portland cement, fly ash and lime are used to provide silicates and calcium. A cement-like hydration reaction occurs, water chemically reacts with the additives, and the resultant material chemically binds inorganic contaminants. The treated material would have to be stockpiled after cleanup, until the backfill activity occurs. This option may impact future bridge maintenance work if excavation in the backfill area is ever required. The proposed stockpile site is at an SR staging area. Space available for staging areas for equipment and materials becomes constrained. This alternative leaves seismic retrofit project areas with lead concentrations below cleanup levels, immobilizes lead by on-site treatment, and disposes of treated material on-site. This alternative is retained for detailed analysis.

7.3.4 Alternative D: In Situ Chemical Fixation

No in situ treatment has been identified that can remove lead. In situ fixation would bind lead in place, leaving behind soil which would exceed the site specific cleanup level for lead in soil and would require specially trained hazardous waste workers for all seismic retrofit excavation work. For these reasons this alternative was rejected.

7.3.5 Alternative E: Ex Situ Chemical Fixation, On-site Use as Roadbase Under an Asphalt Cap

Unpaved roads on-site would be paved in lieu of removing contaminated material to render the lead unavailable to the environment. Roads would need to be modified for drainage, by grading and adding base. Removed material from SR construction areas would be treated by fixation for use as base, then placed below an asphalt cap. Pre-treatment by physical separation may be used to reduce the volume of contaminated material to be treated for use as roadbase. This alternative was retained for detailed analysis.

7.3.6 Alternative F: Ex Situ Acid Leaching, Recycle Lead Off-site, Return Cleaned Soil to Surface

Contaminated material would be excavated and then treated on-site by acid extraction to recover lead from sand and soil. Acid extraction is a technology adapted from the mining industry, used to recover low concentration minerals from tailings. Heavy metals, including lead, tend to be more soluble in acidic solutions. Sand and soil would be cleaned to levels consistent with site risk-based cleanup levels by extracting the lead. A lead concentrate would be recovered for resource recovery off-site, and the soil/sand would remain on-site for use as cover. This method introduces hazardous material, an acid, on-site. The lead is currently in an insoluble form and this technology mobilizes the lead into a dissolved form that presents a potential of loss through leaks or spills. The suitability of the treated sand and soil for flora and fauna is unknown. This alternative was retained for detailed analysis.

7.3.7 Alternative G: Ex Situ Acid Leaching, Recycle Lead Off-site, Use Cleaned Soil as Structured Backfill

Contaminated material would be excavated and treated on-site by acid extraction to recover lead from sand and soil using the same technology described in Alternative F. A lead concentrate would be recovered for resource recovery off-site, and the soil/sand would remain on-site for use as structured backfill in SR excavations. This method introduces a hazardous material, an acid, on-site, and mobilizes the currently insoluble lead into a dissolved form that presents a potential of loss through leaks or spills. This alternative was retained for detailed analysis.

7.3.8 Alternative H: Remove Material to Recycle at an Off-site Asphalt Plant

The contaminated sand, and possibly the contaminated soil may be acceptable for treatment at an asphalt plant. Asphalt plant treatment incorporates the sand and soil into the asphalt as bulking material. The contaminants are encapsulated in the asphalt matrix. The asphalt product is subsequently used in normal asphalt operations, with no special requirements. This approach is not acceptable for RCRA regulated wastes, but is allowed for certain California regulated hazardous wastes. It is expected that the bulk of the material from the site, if transferred off-site, would be a RCRA regulated waste, so this alternative would only have limited applicability, and was not selected.

7.3.9 Alternative I: Ex Situ Encapsulation With Resin, Use as Roadbase Under an Asphalt Cap

Unpaved roads on-site would be paved in lieu of removing contaminated material to render the lead unavailable to the environment. Roads would need to be modified for drainage, by grading and adding base. Removed material from SR construction areas would be treated by encapsulation for use as base, then placed below an asphalt cap Encapsulation is a process involving the complete enclosure of contaminants with a resin or binder. Pre-treatment by physical separation may be used to reduce the volume of material to be treated for use as roadbase. Due to long-term road maintenance requirements, the probability of future trenching through roadways for utilities or culverts, potential incompatibility with GGNRA long term roadway plans, and cost in excess of the cost for similar Alternative E, this alternative was not selected.

7.3.10 ALTERNATIVE J: ENCAPSULATE ROADS IN SITU, ENCAPSULATE OTHER AREAS EX SITU FOR USE AS STRUCTURED FILL

Moore Road, from the Lime Point Lighthouse to Conzelman Road, would be treated in place using resin encapsulation. Contaminated sand and soil would be removed from all other areas. The excavated material may be pre-treated by physical separation, and would be encapsulated for use as backfill. This alternative is comparable to chemical fixation alternatives C, but the resin encapsulation treatment is more expensive, so it was not selected.

7.3.11 ALTERNATIVE K: REMOVE MATERIAL TO AN OFF-SITE LANDFILL

The excavated material would be hauled off-site for treatment and disposal. This alternative is potentially the most expensive, due to the cost of transportation, treatment, hazardous waste disposal and taxes. Volume reduction by means of screen separation or other expedient methods would be necessary to control costs. Transported material would be analyzed to determine if it is classified as a hazardous waste, and manifested accordingly. Due to cost, transportation risk, and long-term potential liability, this alternative was not selected.

7.3.12 ALTERNATIVE L: VACUUM SAND, RECYCLE OFF-SITE VIA LEAD SMELTING

A lead smelter received samples of sand for evaluation as a feed material. The smelting operation needs sand, and the presence of lead is a bonus as it will be recovered in their operation. This option is applicable only to sand that has been screened and is free of soil. To the extent that vacuum removal technology is used, sand would be accumulated and may be stockpiled separate from soil. Due to capacity limitations at the smelter and associated logistics difficulties this option was not selected.

7.3.13 ALTERNATIVE M: NO ACTION

The no action alternative is not viable because it would leave in place lead at levels exceeding the site specific cleanup level. However, U.S. EPA guidance requires the no action alternative be retained for detailed analysis.

7.4 FINAL REMEDIAL ALTERNATIVES

The preliminary remedial alternative screening resulted in five final remediation alternatives. These alternatives, listed in Table 7-4, were subjected to the detailed analysis that follows. Each alternative and its performance relative to each NCP criteria is discussed.

7.4.1 ALTERNATIVE C EX SITU CHEMICAL FIXATION WITH ON-SITE USE AS STRUCTURED BACKFILL

This alternative would remove all visible sand accumulations and contaminated surface soil using vacuum or other excavation techniques. A staging area at the north approach would be treated in situ, and then used as the location for a stockpile of all material removed from other portions of the site and treated ex situ. The in situ treatment and the ex situ treatment would be chemical fixation. Field XRF analysis would be used to verify the concentrations of lead and zinc remaining on-site, for comparison with the risk based cleanup level. Upon completion of seismic retrofit foundation work the treated, stockpiled material would be used for structured backfill of the foundation excavations. an engineered cap and drainage control systems would be placed over the backfill area.

Overall Protection of Human Health and the Environment

This alternative would remove surface sand and contaminated soil from all portions of the Phase I site down to lead concentrations consistent with the level determined by the human health risk assessment. The cleaned areas would then be protected from recontamination by run on and run off using drainage controls. Removed material would be treated by chemical fixation to reduce the solubility of lead, as well as any zinc or

Table 7-4. **Final Remediation Alternatives for Detailed Analysis.**

ALTERNATIVE	DESCRIPTION
C	Ex situ chemical fixation, on-site use as structured backfill
E	Ex situ chemical fixation, on-site use as roadbase under an asphalt cap
F	Ex situ acid leaching, recycle lead off-site, return cleaned soil to surface
G	Ex situ acid leaching, recycle lead off-site, use cleaned soil as structured backfill
M	No action

other metals. The treated material would be stockpiled until the Seismic Retrofit Project excavations are ready to be backfilled. The stockpile would be protected from human access by fencing, and would be provided with drainage controls to prevent spread of contaminated material by run on and run off of precipitation and/or surface water. Treated stockpile material would be transferred into the excavations and compacted in place, then capped with compacted clay or a synthetic material. Surface drainage would also be provided. The treatment would render the contaminants insoluble in acidic environments sufficient to pass the federal criteria for leaching (TCLP). The compaction, cap, and surface drainage controls would physically limit the availability of contaminants to surface and ground water. Although chemically fixed and then placed below an engineered cap, the lead is still present on the site. Interpretation of data provided by a geotechnical investigation shows groundwater is found at a depth of approximately 42 feet below tower three, the proposed backfill location. The depth of excavation to allow strengthening of the tower three foundation is planned to approach thirty feet, leaving a barrier of approximately ten feet of clay between the backfill and underlying groundwater.

Human health is protected through compliance with the health risk based cleanup level, through dust control to comply with airborne particulate and lead limits, through treatment to comply with federal TCLP, and through capping.

The environment is protected through those same measures, and through drainage and erosion controls including sediment traps to minimize surface transport of particulate lead (paint chips). Use of the material as fill will be limited to unsaturated zones to avoid any threat to the environment associated with contact between fill material and groundwater.

Compliance with Applicable and Relevant or Appropriate Requirements (ARARs)

This alternative would be designed and implemented in compliance with ARARs that set the site cleanup level, the limitations on airborne particulate and lead, and federal RCRA standards including the TCLP limit of 5 mg Pb/liter extract. The RWQCB requires five feet of separation between contaminated backfill and the water table. Field data from geotechnical work by the GGBH&TD indicates the groundwater will be about ten feet below the fill area (Geospectra, June 1994).

Long Term Effectiveness and Permanence

This alternative leaves Phase I ground surfaces permanently cleaned to contaminant levels consistent with the results of the human health risk assessment. Materials with higher contaminant concentrations would be treated and permanently capped to limit the contaminant availability to the environment. The treated product will be tested for compliance with TCLP criteria to confirm that the lead and zinc are insoluble.

Reduction of Toxicity, Mobility, or Volume Through Treatment

Chemical fixation will treat the contaminated material to reduce the mobility, and to reduce the toxicity as measured by the EPA Toxicity Characteristic Leaching Procedure (TCLP). Mobility is limited in two ways, first by reduction of solubility of lead and other inorganics by chemically binding into an insoluble form, and second by compacting in place and capping with two feet of clay to physically limit the availability of contaminants to ground water or surface water. Toxicity of the treated material will be limited by the reduced solubility that results, and will be measured by the TCLP criteria which tests solubility in acidic conditions. The treatment of contaminated sand and soil to pass TCLP criteria, followed by use as structured backfill where no sources of acidic leachate are available, reduces the potential for leaching.

Chemical Fixation Vendor Results

	Soluble Lead by TCLP (mg/liter)		Total Lead (mg/kg)
Sample	Untreated	Treated	
1	22.1	0.39	not reported
2	40.1	0.28	665
3	18.3	0.28	1079
4	37.8	0.39	3435
5	41.3	0.39	4950

Since the total lead remains present, toxicity related to total lead, such as that related to human ingestion, may not be reduced by this treatment. However, risk is reduced by making the contaminated material unavailable by compacting the material and placing an engineered cap over the backfill area. Ecological risks that may be related to solubility such as plant uptake will be reduced by fixation.

Chemical fixation does increase rather than decrease the volume of the material being treated. A volume increase of 5% to 15% is expected for the material from this site, if all contaminated material is chemically fixed. A pre-treatment by physical separation may reduce the volume of material to be treated by fixation by 90%, based on preliminary vendor data.

Short Term Effectiveness

This alternative is immediately effective at reducing levels of contaminants in the Phase I areas to levels consistent with the results of the human health risk assessment. The removed material will be treated as it is removed. Chemical fixation treatment requires a "cure" period, like concrete, before the chemical reaction is complete. However, testing for TCLP criteria purposes will be performed within 48 hours of treatment. Subsequent cure beyond that time will only further reduce contaminant mobility and toxicity. The use of TCLP as criteria requires a delay time, the fastest analytical turnaround time is approximately 32 hours. A short term potential hazard is the stockpiling of treated material. Risk would be associated with transport of contaminated material by wind, or precipitation and associated run on and run off. This risk would be mitigated by the treatment which reduces solubility, by protective curbs, ditches, and sediment traps to control run on and run off, and by a protective cap of an encapsulating resin, asphalt, high density polyethylene liner material, or other synthetic cover.

Ability to Implement

The removal of contaminated material from the site by vacuum, more traditional heavy earth-moving type equipment, and localized use of hand tools, to obtain the desired reduction in lead concentrations, has been demonstrated at this or other sites and can be readily implemented. Similarly the technology to compact and cap the treated material can be readily implemented. Chemical fixation treatment technology has been used throughout the United States and is the preferred method of complying with the EPA Land Ban, which requires treatment of hazardous wastes prior to land disposal. Chemical fixation can readily be implemented through most remediation contractors and with specialty vendors who offer proprietary recipes of chemical fixation agents.

Pre-treatment by physical separation to reduce the volume of contaminated material would require bench scale, and possibly pilot scale testing, depending on the method being tested.

Cost

The cost to implement this alternative on both approaches, up through the stockpile stage is $2,000,000, based on the preliminary draft design. This cost is based on an additive ratio of 22% and vendor based costs of $16.25/ton for mixing, and $54/ton waste for reagent. The EPA SITE (Superfund Innovative Technology Evaluation) Program suggests a range of $120 to $255/CY (approx. $80 to $170/ton) waste for inorganic contaminants, with reagent being $80 to $150/CY waste and mixing being $40 to $175 per CY (approx. $26 to $120/ton). Comparing to EPA SITE Program data, this $2 million provides only for the low end of the expected range for additive, and is off scale on the low end for mixing. Adjusting the mixing cost up from the $16.25/ton to the $30 to $60/ton range adds from $260,000 to $750,000 to the estimate, for an adjusted price range of $2.25 to $2.75 million without backfill and cap. Additional cost related to transfer of the stockpile and associated pad to the backfill site, compaction, clay cap, and revegetation is approximately $250,000 to $500,000 for a total cost range of $2.5 to $3.25 million. Pre-treatment by physical separation methods would be considered to the extent that they can be cost effective, reducing total treatment volume and cost.

The GGBH&TD will also be committed to long term costs for maintenance of the engineered cap.

State Acceptance

This section is reserved for state input. However, DTSC has agreed in concept to this approach for this site. This technical approach has been approved by DTSC for many other heavy metal contaminated sites.

Community Acceptance

This section is reserved for the public review and public hearing process.

7.4.2 ALTERNATIVE E: CHEMICAL FIXATION AS ROADBASE, BELOW AN ASPHALT CAP

Alternative E would remove surface sand and contaminated soil from all portions of the Phase I site, except for access roads, down to lead concentration levels consistent with level determined by the human health risk assessment. The cleaned areas would then be protected from recontamination by run on and run off using drainage controls. Removed materials would be treated by chemical fixation to bind the lead (and zinc). Material from the south approach would be treated and tested to verify that the treated material is in compliance with TCLP criteria prior to transport to the north approach. For contaminated material from the north approach, the treatment reagents would be mixed as the contaminated sand and soil is distributed over site roads as base material, graded, and capped with asphalt to establish desired finish elevations. The GGBH&TD would be responsible for long term maintenance of the asphalt road surface. The actual roads or road sections to be paved would be subject to discussion with GGNRA.

Overall Protection of Human Health and the Environment

Alternative E protects human health by removing lead contaminated material from the Seismic Retrofit Project construction and staging areas as required to meet the human health based risk assessment. Dust controls during the removal, treatment, and asphalt paving process will limit exposure of workers and the public to airborne dust and lead.

Implementation of this alternative would be protective of the environment by complying with conditions of the seismic retrofit project biological assessment.

Placement below an asphalt cap keeps contaminated material near the surface, reducing any threat to groundwater, but may trigger health and safety concerns during future road and utility work.

Compliance with ARARs

This alternative would be designed and implemented in compliance with ARARs. Specifically, any contaminated material transported over the bridge would first be treated and tested to verify that the material passes the TCLP criteria. This alternative would clean, as necessary, the seismic retrofit staging and construction areas to provide reduced contaminant exposures to the seismic retrofit workers, per the human health risk assessment and resultant cleanup level. Paving of Moore Road may be subject to BCDC approval because of their jurisdiction within 100 feet of the high tide line. This alternative and associated final waste elevations would be in compliance with RWQCB regulations limiting the proximity of waste to groundwater.

Long Term Effectiveness and Permanence

This alternative leaves Phase I ground surfaces permanently cleaned to contaminant levels consistent with the results of the human health risk assessment. Materials removed from the Phase I areas, with higher contaminant levels, would be treated with chemical fixation reagents. The resultant treated product would be resistant to leaching, and would be protected from weathering and degradation by the asphalt cap. Long term maintenance of the asphalt cap, or road surface, would be provided by the GGBH&TD.

Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative reduces the toxicity and mobility of the contaminants. The volume of contaminated material will increase.

Toxicity, as measured by the TCLP test, will be reduced to levels below the federal standards that trigger classification as a RCRA hazardous waste. Chemical fixation has been shown to pass TCLP criteria, which measure the solubility of the contaminants in an acidic environment. Chemical fixation chemically binds the contaminants to render them insoluble.

Mobility is reduced by the chemical fixation, by binding the contaminants to render them insoluble. Mobility is further reduced by the asphalt cap, limiting the availability of the material to the environment.

Volume will increase up to 15% due to the addition of the reagents to the contaminated sand and soil.

Short Term Effectiveness

This alternative is immediately effective at reducing levels of contaminants in the Phase I areas to levels consistent with the human health risk assessment. The removed material will be treated as it is placed as roadbase, or prior to transport across the bridge when transport occurs. Chemical fixation treatment required a "cure" period, but the treated soil would be tested for TCLP compliance within 48 hours of treatment. The TCLP testing requires at least another 32 hour turnaround time before results are available.

Ability to Implement

The removal aspects of this alternative can be readily implemented. The chemical fixation treatment is very similar to typical road building operations, and is implemented with standard road building equipment. The treated material would be subject to compaction and structural requirements consistent with use as roadbase. Chemical fixation actually enhances the structural strength of sand and soil. The capping with asphalt would be designed and implemented as a standard paving project.

The implementation of this alternative is subject to discussion with GGNRA, and consideration of long term GGNRA plans for roads. Future utility, construction, or road work would be impacted by implementation of this alternative.

Cost

A rough order of magnitude cost estimate of this alternative gives a range of \$2.0 to \$2.5 million. This alternative also commits the GGBH&TD to long term routine maintenance of the asphalt pavement in all areas where treated waste material is used as roadbase.

State Acceptance

DTSC has approved chemical fixation as the remedial technology of choice for may sites contaminated with lead or other heavy metals.

Community Acceptance

This section is reserved for the public review and public hearing process.

7.4.3 ALTERNATIVE F: EX SITU ACID LEACHING, RECYCLE LEAD OFF-SITE, RETURN CLEANED SOIL TO SURFACE

This alternative would remove surface sand and contaminated soil from all portions of the Phase I site down to lead concentration levels consistent with the level determined by the human health risk assessment. The cleaned areas would then be protected from recontamination by run on and run off using drainage controls. Removed materials would be treated by acid leaching to extract the lead, as well as zinc or other metals. The treated materials would be returned to the site to reestablish prior contours. The acid containing the dissolved metals would be hauled off-site to a lead smelter for recycling.

Overall Protection of Human Health and the Environment

This alternative would be protective of human health in that it would clean the seismic retrofit project areas to contaminant levels consistent with the results of the human health based risk assessment. Remediation workers and the public would be protected by implementation of dust controls to reduce airborne particulate and lead.

The environment would be protected by the same measures stated above for human health, as well as by a biologist-monitored protection and revegetation plan for environmentally sensitive areas, in compliance with the conditions of the seismic retrofit project biological assessment.

In the short term this alternative introduces bulk acid to the site, and takes contaminants that are insoluble and makes them soluble, in a concentrated liquid solution. The potential for a leak or spill during operation of the treatment system presents some chemical exposure risk to workers. The treatment system and associated chemicals would be located within a secondary containment system to prevent an acid or soluble lead release to the ground if a leak or spill from the treatment system were to occur.

In the long term the contaminants are removed from the site and recovered for reuse. The sand and soil returned to the site would be sterile, and would require amendments to restore organic content. The vendor has provided assurances and presented data from tests for other sites indicating an ability to produce treated product that is in compliance with solubility criteria as measured by TCLP.

Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

This alternative would be designed and implemented in compliance with ARARs. The site would be cleaned to contaminant levels consistent with the results of the human health risk assessment. Dust control measures will be used during remediation to limit worker and public exposure to particulates and lead. No contaminated or treated site soil will be transported across the bridge. Concentrated contaminant solution will be transported from the site to an appropriately licensed lead recycling or recovery facility, in accordance with DTSC, DOT and EPA requirements.

Long Term Effectiveness and Permanence

This alternative leaves Phase I ground surfaces permanently cleaned to contaminant levels consistent with the results of the human health risk assessment. Materials removed from the Phase I areas, with higher contaminant levels, would be treated by acid leaching to extract metals. The contaminated sand and soil would be treated to lead concentrations below the risk based cleanup level. The lead and zinc would be permanently removed from the site and recovered for beneficial use by recycling at a lead smelter.

The nature of the residual lead in the material returned to the site is uncertain. Total residual lead will be below the health risk based cleanup level. The vendor has provided assurances and data from tests on materials from other sites indicating an ability to remove high levels of total lead down to residual soluble lead less than 5 mg/liter, as measured by TCLP. If the residual lead is in a soluble state the long term risk of soil and groundwater contamination may be increased, not reduced by this alternative. This risk can be mitigated, if this residual solubility issue exists, by adding a chemical fixation treatment step.

Off-site recycling of the lead may be risky as many of today's lead remediation projects are former lead smelters and other lead recycling sites. The GGBH&TD may incur liability for future remediations if lead is sent off-site to a recycling or disposal facility.

Reduction of Toxicity, Mobility, or Volume through Treatment

Acid leaching to extract metal contaminants generally reduces toxicity, mobility, and volume by concentration of the contaminants into a solution that is then recycled. After treatment the concentration of contaminants remaining in treated soil or sand will be significantly reduced. A vendor demonstration gave the following results, all in mg/kg:

	Lead		**Zinc**	
	Untreated	**Treated**	**Untreated**	**Treated**
Sand	6,800	280	11,000	13
Soil	1,800	46	700	18

The solubility of the contaminants left in the treated soil is uncertain. The vendor has provided assurances and data from tests on materials from other sites indicating a residual soluble lead below TCLP criteria. If soluble residual lead is excessive, a chemical fixation treatment step could be added.

Conceptually, the sand and soil from this site is clean, it simply contains paint chips that contain lead. This technical approach mobilizes all the lead from the paint chips, and exposes all the sand and soil to soluble lead.

Short Term Effectiveness

This alternative can be immediately effective at reducing levels of contaminants in the Phase I areas to levels consistent with the human health risk assessment. The removed material will be treated as it is removed. Acid leaching treatment is immediately effective, the treated soil would be tested for total lead, which can be done rapidly on-site. A short term potential hazard is the presence of bulk acid inventory on-site during treatment; the loading, unloading, and transport of the acid; and the conversion of highly insoluble lead to lead in solution, which would be subject to spills. This short term risk is easily mitigated by the use of secondary containment systems around the treatment equipment, any associated chemical storage tanks, and any loading/unloading connections.

Ability to Implement

The removal aspects of this alternative can be readily implemented, however, acid leaching treatment is an innovative technology. The number of full-scale acid leaching remediation projects is very limited, as is the number of vendors. The technology itself is not new or innovative, as versions of it have been used in mining for decades. The application of the technology to metals contaminated sites is new. Firms known to have expertise include:

- Hazen Research - A respected mining research firm based in Colorado that is a domestic leader in soil washing and leaching technology research. They have no known commercial scale implementations for remediation.

- Cognis - A Santa Rosa, California firm merged with a European firm with European soil washing and leaching experience. They have a patented process, and widely published success at former Army munitions depot in

Minnesota. Cognis was not interested in obtaining GGB material for bench testing.

- Earth Treatment Technologies - A Gold River, California firm has been the source of bench test results for GGB. They have a patented process, with demonstration scale work for CalTrans and others, and two known full scale applications, one completed, (1,200 tons), and a second ongoing (26,000 tons).

Based on the limited sources of this technology, and the immature state of this technology, it may be readily implemented, but GGBH&TD assumes technical and financial risk in the form of uncertainty.

Cost

The expected cost range of Alternative F is $2.9 to $4.2 million, based on a treatment cost range of $130 to $175/ton, as estimated by a vendor after performing preliminary bench scale testing.

State Acceptance

This section is reserved for state input. It is anticipated that the state would support this approach, in the interest of actually removing the lead. There is however, no known acceptance of acid leaching as the remedial technology at any DTSC site. GGBH&TD and the vendor would assume the burden of proving the technology to DTSC. State acceptance may be subject to presentation of solubility data for the cleaned sand and soil.

Community Acceptance

This section is reserved for the public review and public hearing process. It is anticipated that GGNRA and the public in general would prefer this alternative to leaving the lead on-site, in any form. Acceptability may be tempered if the residual lead in cleaned soil is highly soluble. The quality of the cleaned sand and soil, and its acceptability for use by flora and fauna would be a concern.

7.4.4 ALTERNATIVE G: EX SITU ACID LEACHING, RECYCLE OFF-SITE, USE CLEANED SOIL AS STRUCTURED BACKFILL

This alternative would remove surface sand and contaminated soil from all portions of the Phase I site down to lead concentration levels consistent with level determined by the human health risk assessment. The cleaned areas would then be protected from recontamination by run on and run off using drainage controls. Removed materials would be treated by acid leaching to extract the lead, as well as zinc or other metals. The cleaned sand and soil would be stockpiled until completion of seismic retrofit foundation work, when it would be used as structured backfill in foundation excavations. Material from the south approach would be treated prior to being transported across the bridge to the stockpile area. The treatment would meet both the total lead level limited by the risk based cleanup level and the TCLP criteria of 5 mg Pb/liter extract. The contaminants would be concentrated in a dissolved state, and hauled off-site to a lead smelter for recycling.

Overall Protection of Human Health and the Environment

This alternative is generally protective of human health and the environment because it reduces the level of lead on-site to the human health risk based cleanup level, it uses dust control during remediation to limit airborne particulate and lead, it removes lead from the site and recovers it for beneficial use, and the remediation will be performed in accordance with the biological assessment prepared for the seismic retrofit project.

In the short term this alternative introduces bulk acid to the site, and takes contaminants that are insoluble and makes them soluble, in a concentrated liquid solution. The potential for a leak or spill during operation of the treatment system presents some chemical exposure risk to workers. The treatment system and associated chemicals would be located within a secondary containment system to prevent an acid or soluble lead release to the ground if a leak or spill from the treatment system were to occur.

In the long term the contaminants are removed from the site and recovered for reuse. The treated sand and soil would be sterile, and would be stockpiled for subsequent use as structured backfill. The solubility of the residual lead may be elevated, but vendor assurances and test data from other sites indicate the treated material can be in compliance with TCLP criteria.

Compliance with ARARs

This alternative would be designed and implemented in compliance with ARARs. The contamination level left on-site would be less than the human health risk based level. Dust control measures during remediation would limit airborne particulate and lead. Treated sand and soil hauled over the bridge would meet the TCLP criteria of 5 mg Pb/liter leachate. Lead concentrate hauled off-site would be managed according to DTSC, DOT and EPA requirements. Treated material placed in the stockpile may be subject to BCDC requirements. The cleaned sand and soil used as structured backfill is not likely to trigger RWQCB waste discharge requirements.

Long Term Effectiveness and Permanence

This alternative leaves Phase I ground surfaces permanently cleaned to contaminant levels consistent with the results of the human health risk assessment. Materials removed from the Phase I areas would be treated by acid leaching so that lead concentrations would be below the risk based cleanup levels. The lead and zinc would be permanently removed from the site and recovered for beneficial use by recycling at a lead smelter.

If the residual lead is highly soluble, the use as structured backfill may contribute to future groundwater contamination. The vendor has test data from material from other sites that show the residual lead solubility was low, and it passed the TCLP criteria. This alternative requires the material from the south approach be treated to pass TCLP prior to transport over the bridge. The vendor has provided assurances that the cleaned sand and soil can meet the TCLP criteria.

Off-site recycling of lead may be risky, as many of today's lead remediation projects are former lead smelters and other lead recycling sites. The GGBH&TD may incur liability for future remediations if lead is sent off-site to a recycling or disposal facility.

Reduction of Toxicity, Mobility, or Volume through Treatment

Acid leaching to extract metal contaminants reduces toxicity, mobility, and volume by concentration of the contaminants into a solution that is then recycled. After treatment then concentration of contaminants remaining in treated soil or sand will be significantly reduced. A vendor demonstration gave the following results, all in mg/kg:

	Lead		Zinc	
	Untreated	**Treated**	**Untreated**	**Treated**
Sand	6,800	280	11,000	13
Soil	1,800	46	700	18

An uncertainty is the solubility of the contaminants left in the treated soil. The vendor has provided assurances and data from testing on materials at other sites showing treated soil in compliance with TCLP criteria, which may indicate that solubility of residual lead is limited. If the cleaned material does contain soluble lead a chemical fixation step could be added.

Short Term Effectiveness

This alternative can be immediately effective at reducing levels of contaminants in the Phase I areas to levels consistent with the human health risk assessment. The removed material will be treated as it is removed. Acid leaching treatment is immediately effective, the treated soil would be tested for total lead, which can be done rapidly on-site. A short term potential hazard is the presence of bulk acid inventory on-site during treatment, and the conversion of highly insoluble lead to lead in solution, subject to spills and migrations laterally and vertically through soil. The risk of release of this acid or soluble lead can be reduced by providing adequate secondary containment systems around the treatment equipment and associated chemical tanks.

Ability to Implement

The removal aspects of this alternative can be readily implemented, however the acid leaching treatment is very much an innovative technology. The number of full-scale acid leaching remediation projects is very limited, as is the number of vendors. The technology itself is not new or innovative, versions of it have been used in mining for decades. The application of the technology to metals contaminated sites is new. Firms known to have expertise include:

- Hazen Research - A respected mining research firm based in Colorado that is a domestic leader in soil washing and leaching technology research. They have no known commercial scale implementations for remediation.

- Cognis - Out of Santa Rosa, CA, merged with a European firm with European soil washing and leaching experience. They have a patented process, and widely published success at former Army munitions depot in Minnesota. Cognis was not interested in obtaining GGB material for bench testing.

- Earth Treatment Technologies - Out of Gold River, California has been the source of bench test results for GGB. They have a patented process, with demonstration scale work for CalTrans and others, and two known full scale applications, one completed (1,200 tons), and a second ongoing (26,000 tons).

Based on the limited sources of this technology, and the immature state of this technology, it may be readily implemented, but GGB assumes technical and financial risk in the form of uncertainty.

Cost

The expected cost range of Alternative G is \$3.1 to \$4.3 million, based on a treatment cost range of \$130-\$175/ton plus the backfill activity, with no need for landfill liner or cap systems.

State Acceptance

This section is reserved for state input. It is anticipated that the state would support this approach, in the interest of actually removing the lead. There is, however, no known acceptance of acid leaching as the remedial technology at any DTSC site. GGBH&TD and the vendor would assume the burden of proving the technology to DTSC. Limited solubility of the residual lead would have to be demonstrated. There may be some negative aspect of presenting a change in approach to DTSC at this time.

Community Acceptance

This section is reserved for the public review and public hearing process. It is anticipated that GGNRA and the public in general would prefer this alternative to leaving the lead on-site, in any form. The public would likely want assurances of limited solubility of residual lead in cleaned sand and soil destined for use as backfill.

7.4.5 ALTERNATIVE M: NO ACTION

In this alternative, no actions would be taken to treat or remove contaminated soils. The existing controls on access to the site, including fences, would be maintained. The No Action alternative is included in this detailed evaluation of alternatives as a baseline for the comparison of other remedial alternatives, according to CERCLA guidance.

Overall Protection of Human Health and the Environment

This alternative would not meet the Remedial Action Objectives for protection of human health and the environment. Potential exposure pathways to chemicals of concern would remain. The use of fences to control public access to the site would provide some reduction of the potential health risks but would leave lead-contaminated soils in place and untreated. Because activities associated with the Seismic Retrofit Project would take place within fenced areas and workers would be exposed during the course of the SR Project to lead in dust and soil from the site, workers would require additional protection.

Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

The no action alternative would not comply with ARARs.

Long-Term Effectiveness and Permanence

The no action alternative would not be effective in meeting the remedial action objectives in the long term. The potential risks to public health and the environment would remain.

Reduction of Toxicity, Mobility, or Volume Through Treatment

The no action alternative would provide no reduction of the toxicity, mobility, or volume of contaminated material.

Short-Term Effectiveness

This alternative would introduce no additional detrimental effects during implementation.

Ability to Implement

There would be no implementation difficulties for this alternative.

Cost

There would be minor maintenance costs associated with fence maintenance for the no action alternative.

State Acceptance

This section is reserved for state input. The no action alternative would not meet the remedial action objectives and it is unlikely that this alternative would be acceptable to the DTSC or other agencies.

Community Acceptance

This section is reserved for the public review and public hearing process. It is unlikely that the community would find this alternative acceptable.

7.5 RECOMMENDED FINAL REMEDIAL ACTION

The result of the detailed analysis of the remedial alternatives is to select a modified Alternative C that allows for, and encourages, pre-treatment of contaminated material. This pre-treatment results in a reduced volume of contaminated material for stabilization, stockpile, and backfill, and a clean material that will also be stockpiled for use as backfill.

7.5.1 REMEDIAL ACTION ALTERNATIVE RECOMMENDED

The specific tasks involved in the removal and site preparation activities include vacuum removal of sand and soil, vegetation removal, demolition of structures, heavy equipment removal of sand and soil, erosion and drainage control, verification testing, equipment decontamination, treatment, stockpile, and backfill of the sand and soil.

The estimated quantity of sand to be removed is 4,000 cubic yards. The estimated amount of soil to be removed is 4,800 cubic yards. The estimated amount of roadbase to be removed is 1,100 cubic yards. These are in place estimates of quantity and will increase 5% to 15% when excavated.

In all Seismic Retrofit Project construction and staging zones, surface sand and underlying soil will be removed until the lead concentration in the remaining soil meets the risk based cleanup criteria, as verified using hand-held XRF with appropriate confirmatory analysis. Similarly, along unpaved access roads, roadbase will be removed until the residual lead concentration meets the risk based cleanup level. To protect workers, and reduce any potential recontamination of Seismic Retrofit zones, perimeters of access roads, construction, and staging areas will be cleaned to remove loose sand and paint chips.

A section of one staging area at the north approach will be the treated material stockpile location. It will be treated by stabilization prior to use as a treatment and stockpile location. Removal of roadbase in that area will be deferred until the stockpile is removed for use as backfill.

In addition to Seismic Retrofit Project zones, accessible zones within the Area of Potential Effect, such as the Lighthouse Keeper's Bluff, will be cleared of surface sand only. Any residual lead in soil at levels above the cleanup criteria in those areas will be considered in Phase II of the Lead Cleanup Project.

Vacuum Removal

Vacuum truck removal of contaminated soil is an approach that pilot testing has shown can successfully remove the surficial sand layer from the underlying soil. Vacuum trucks have the capability of reaching remote areas by stretching out hoses to distances up to 1000 feet horizontally and 300 feet vertically. They work well in confined spaces and with material layers of varying thicknesses. Vacuum trucks are also available with continuous offloading capabilities so that vacuuming can continue while removed material is loaded into trucks or containers and hauled to treatment and/or stockpile locations.

Perimeters of construction, staging, and access areas will be cleared of bulk surficial sand by vacuum. Fencing, where no fence currently exists, will then be installed to delineate cleaned areas and to prevent construction worker access to contaminated areas.

A vacuum truck will be used to remove bulk sand and to remove sand and soil in areas with no access for heavy equipment. Compacted sand/soil may need to be loosened prior to vacuuming. Accessible areas within the Area of Potential Effect, but outside of the Seismic Retrofit Project zones will be cleaned by vacuum only. This approach will remove the bulk of the lead, without damaging structures such as foundations at the Lighthouse Keeper's Bluff.

Vegetation Removal

The Seismic Retrofit construction, staging, and access zones will be grubbed of vegetation, and divided into grids based on guidelines set forth in the Sampling and Analysis Plan, Verification. Vegetation will be removed to within six inches of the ground, chipped and tested to verify lead levels, then disposed of accordingly. Vegetation removal will be implemented prior to heavy equipment clearing of sand and soil to minimize contact of vegetation with lead in the soil, and to minimize organic material in the removed sand and soil. Excessive organic material may impact the treatment system by plugging equipment, preventing thorough mixing, and reducing the stabilization additive performance. Trees and scrub will be removed by chainsaw or other tools. Grass and low scrub will be removed using hand tools, mowers, and "weed-eaters" where possible. Areas with limited access or steep terrain may be proposed for removal using herbicide. Any herbicide use will be in accordance with the Seismic Retrofit Project biological assessment and subject to GGNRA review.

Demolition

The cleanup contractors will remove two concrete and wood sand storage sheds from the north approach. Miscellaneous existing railing, fences, picnic tables and garbage cans will also be removed. Concrete rubble will be hauled off-site for appropriate disposal, or used as fill on-site. Picnic tables and garbage cans will be stored for future use. Miscellaneous steel and wood debris will be disposed off-site.

Heavy Equipment Removal

Heavy equipment will be used to scrape surface sand and soil where terrain will allow. Excavation is commonly used to remove contaminated soil with material characteristics and quantities similar to those in this Phase I lead removal (EPA, Survey of Materials - Handling Technologies . . .). The required equipment (graders, loaders, bulldozers, and backhoes) is readily available, and versatile. The limitations of heavy equipment for soil remediation are that the removal rate decreases in confined, extremely steep and/or rocky terrain, and there is a tendency to generate excess material (over-excavation). Heavy equipment methods would likely mix the sand and soil, eliminating potential treatment/disposal/reuse options that may be applicable to just sand or just soil.

Heavy equipment excavation and removal will be used for the Seismic Retrofit Project construction, staging, and access areas that are not excessively steep or confined. The depth of cut in each cell will be staked in the field prior to excavation activities. Actual excavation will continue until lead levels meet the risk-based cleanup level, as verified using hand-held XRF. Actual implementation will be by grid cells, starting at the highest elevations and proceeding, by cells, to lower elevations. XRF testing will be performed to verify that a cell meets the cleanup criteria, or to identify subareas for further removal.

Erosion and Drainage Controls

The GGBH&TD will provide temporary erosion and drainage controls for the duration of the Seismic Retrofit Project, including the site preparation. The controls will prevent potential recontamination of the clean areas by run-on, prevent erosion of denuded areas, and minimize the impact of surface water on site activities. Specific drainage controls include installation of new culverts and "v" ditches, clearing of existing "v" ditches, and the use of hay bales and curbing.

At the south approach an existing "v" ditch along the southern edge of Battery East Road will be cleared of vegetation and sediment. No other drainage controls are anticipated at the south approach.

At the north approach, the seismic retrofit project area receives run-on from Vista Point to the east, and from a large watershed to the west of the viaduct area. Drainage from Vista Point areas will be diverted via a temporary culvert down the east side of the project area to the existing ditch on the north edge of Conzelman Road. Run-off from the west floods existing culverts and washes over Conzelman Road. Run-on from the west will be prevented in work areas with curbs, hay bales, and existing "v" ditches along the north side of Conzelman Road. Temporary "v" ditches will be used within the work areas to channel drainage to a sediment trap.

At the north approach, stormwater discharge along Moore Road will be diverted to new permanent culverts, using a new permanent "v" ditch along the western side of the road. Culverts will be placed at existing low points where drainage currently flows over the road surface.

Erosion controls may include spray on erosion control products including interim vegetative cover. Prior to the use of vegetative cover the seed mix will be specified for GGNRA review.

Verification

Verification testing, with hand-held XRF will take place on-site, within each cell. This verification testing, and any other analytical work for the project, will be performed in accordance with the Quality Assurance Project Plan, Verification (ENTRIX, July 1994). In situ or on-site verification testing will be performed, and cleanup levels verified as removal activities proceed into the next cell. Based on the results of the verfication testing, any areas with lead remaining above cleanup levels will be defined, staked out, removed and re-tested. Verification will also include testing to confirm that zinc concentrations do not exceed the Remedial Action Objective cleanup level. This procedure will continue until all construction and staging zones are cleaned. XRF testing and calibration will be implemented in accordance with the standard operating procedures for soil analysis provided by the XRF device manufacturer. Periodic confirmation samples will be obtained and analyzed for lead by a California certified environmental laboratory, to provide a calibration basis for the XRF device. The detailed verification methodology is described in the Sampling and Analysis Plan, Verification (ENTRIX, July 1994).

Equipment Decontamination

Remediation contractors will provide personnel and equipment decontamination stations to prevent the transfer of lead or paint chips from the contaminated work zone to other areas. A personnel and heavy equipment decontamination station will be established between the exclusion zone and the clean zone. Personnel decontamination will be accomplished with water and soap or sanitary wipes. Decontamination of boots and other reusable equipment will be accomplished by low pressure sprayers and brushes. Heavy equipment will be decontaminated by pressurized water applied within a bermed area or other comparable methods. Decontamination water will be filtered and reused to the maximum extent possible, then collected into drums or temporary tanks. Decontamination water containers will be staged within temporary secondary containment areas. Decontamination water will be held on-site pending analysis for disposal, and will be disposed of off-site or used in the stabilization treatment process.

Treatment

The treatment system will begin with a physical separation step to reduce the volume of contaminated material, followed by stabilization. The physical separation step will include, at a minimum, a screen or series of screens to remove oversize debris and organic material. The physical separation step may also include froth flotation, attrition mixing, dry density separation, centrifugal separation, acid leaching, or other methods. Oversized material retained by the initial screening will be segregated into debris such as hubcaps, rivet heads, and other man-made objects to be disposed off-site; and native material to remain on-site. Debris will be tested using the hand held XRF to confirm non-hazardous levels of lead. Native material will be tested to verify it is below the site risk based cleanup level. Additional physical separation methods may separate materials with high lead concentrations from less-contaminated sands and soils. These cleaner sands and soils, potentially with total lead concentrations below the site specific health based cleanup level (verified by XRF), and soluble lead levels below the TCLP criteria (verified by laboratory analysis) will not need further treatment before being backfilled. The remaining portion of more contaminated material will contain total lead above the site cleanup level, or soluble lead above the TCLP criteria, and will be subsequently treated by chemical fixation.

The final treatment of contaminated material will be chemical fixation using portland cement, silicates, or pozzolonic materials to chemically bind lead in a pozzolan-concrete matrix and render it non-leachable. The treatment additive mix will be designed to avoid creating a monolithic product. The treated material will be friable allowing excavation, compaction and rework using earthmoving equipment. The criteria for treatment is the federal EPA Toxicity Characteristic Leaching Procedure (TCLP) method (EPA Method Number 1311). Vendor tests indicate that an additive ratio of up to 20% meets that criteria. The treatment system may operate on a continuous or batch basis. The actual reagent used, and specific equipment used, will be subject to competitive bid so it may vary across contractors, but treatment system performance will be subject to independent testing.

The continuous chemical fixation treatment system will consist of: a belt scale to measure feed sand and soil mass; a mixer; an additive silo and feed conveyor; and a spray bar for water addition. The belt scale allows measurement for monitoring additive and water rates and for contractor performance tracking.

The batch chemical fixation system will consist of a mixing container and a mixing device, supplemented by additive containers and scales. In a batch approach the soil, additive, and water quantities are predetermined and measured using a scale. Soil is prescreened to remove oversize debris. The measured quantities are added to the mixing container and mixed.

Testing during treatment will include monitoring of additive ratios and daily TCLP testing of treated material to verify effective treatment. The sample preparation and testing time for TCLP testing is approximately 32 hours. Only material that has been confirmed to meet TCLP criteria will be approved for transport across the bridge or for addition to the stockpile. Therefore, treated material from any particular day will be staged at least until the second day after treatment, when test results will be available.

The water acts as a reagent in the chemical fixation chemistry, and provides dust control. Water from decontamination and physical separation pre-treatment, if any, will be used in the chemical fixation treatment system.

The treatment system will initially be set up at the south approach, to treat material removed prior to transport to the stockpile location at the north approach. Upon completion of the south approach, the treatment system will be set up at the stockpile area of the north approach. The specific locations available for use as treatment areas are delineated on Figures 7-1 and 7-2 for the south approach and north approach, respectively.

Stockpile

The stockpile will be located on the Seismic Retrofit staging area at the north end of Moore Road, at the north approach. Prior to removal actions in any other location, the stockpile site will be prepared. Stockpile site preparation will include vegetation removal, in situ chemical fixation of existing base material, and regrading for control of run-on and run-off. Run-off from the stockpile will flow through a sediment trap prior to discharge.

The existing parking lot/staging area will be extended to the north and west by clearing and removing vegetation up to twenty five feet back from the existing limit of vegetation. Vegetation removal will include grinding or removal of remaining stumps and roots that may interfere with in situ chemical fixation additive mixing.

In situ chemical fixation will be achieved by mixing additives in accordance with predetermined mix ratios. In situ soils in this area will be stabilized to a depth of six inches, below which depth no lead concentrations have been measured above the established cleanup levels. Mixing technique will include ripping the existing surface to a depth of six inches, spreading additive over the native soil, and mixing the surface soil and the additive using graders. A water truck will add water for dust control and as a reagent. The surface will be contoured to final grade and compacted with rollers. The chemical fixation additive and water quantities will be predetermined based on the surface area to be treated to a depth of six inches.

A drainage ditch will be installed around the perimeter of the in situ treated area. A permanent "v" ditch will be installed along the north and western edge, directing flow from the high point to new catch basins. The catch basins will trap sediment and allow water discharge through new outlets to the Bay. A separate, temporary drainage ditch will direct run-off from the stockpile to a temporary catch basin/sediment trap, that will direct water flow to one of the permanent catch basins.

The stockpile is projected to contain 11,000 cubic yards, based on a removal of 9,500 yards, with allowance for fluff and stabilization additive. The proportion of stockpile material that is cleaned by pre-treatment versus that which contains lead that is fixed will depend on the success of the pre-treatment. The stockpile location is estimated to have a maximum capacity of 16,000 cubic yards. The stockpile will be treated annually with a commercially available spray-on erosion and dust control product to prevent windblown dust and stormwater erosion with additional applications as needed following severe weather. Figure 7-2 presents a plan and cross section view of the stockpile, including drainage controls.

Structured Backfill

The treated material, both cleaned by pre-treatment and fixed, will be compacted into the Seismic Retrofit excavation around tower 3, immediately to the north of Conzelman Road. The cleaned sand and soil from pre-treatment will be used as backfill in the lower elevations of the seismic retrofit excavations. The material containing stabilized lead will be backfilled near the surface, below a cap. The higher elevation of the stabilized material reduces the potential of exposure to groundwater. In the event that the stockpiled quantity of treated material significantly exceeds estimates, excavations around other towers will be available to fill.

The backfill operation will occur after the Seismic Retrofit excavation and foundation work is complete. At that time the 11,000 cubic yard stockpile will be placed and compacted in lifts up to 18". The pretreated base of the stockpile area will also be excavated and used for fill, with verification by hand-held XRF that base removal is consistent with the site health risk based cleanup level.

An engineered cap will be placed over the backfill, using excavated material and imported clay to achieve a permeability less than 1×10^{-7} cm/sec, or using synthetic materials. Field quality control testing will be performed during construction to verify that a permeability of less than 1×10^{-7} cm/sec is actually achieved for clay, or to verify seam welds and absence of perforations for synthetics. The engineered cap will be overlaid with a minimum of one foot of soil cover. Both the engineered cap and soil cover will be sloped for drainage, and the site perimeter will be graded to prevent run-on. The area will be revegetated for erosion control, with a seed mix and/or vegetation consistent with the Seismic Retrofit Project biological assessment and subject to GGNRA review. Figure 7-3 presents the plan and a cross section of the backfill area.

Stockpile

The stockpile will be located on the Seismic Retrofit staging area at the north end of Moore Road, at the north approach. Prior to removal actions in any other location, the stockpile site will be prepared. Stockpile site preparation will include vegetation removal, in situ chemical fixation of existing base material, and regrading for control of run-on and run-off. Run-off from the stockpile will flow through a sediment trap prior to discharge.

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The backfill operation will occur after the Seismic Retrofit excavation and foundation work is complete. At that time the 11,000 cubic yard stockpile will be placed and compacted in lifts up to 18". The pretreated base of the stockpile area will also be excavated and used for fill, with verification by hand-held XRF that base removal is consistent with the site health risk based cleanup level.

An engineered cap will be placed over the backfill, using excavated material and imported clay to achieve a permeability less than 1×10^{-7} cm/sec, or using synthetic materials. Field quality control testing will be performed during construction to verify that a permeability of less than 1×10^{-7} cm/sec is actually achieved for clay, or to verify seam welds and absence of perforations for synthetics. The engineered cap will be overlaid with a minimum of one foot of soil cover. Both the engineered cap and soil cover will be sloped for drainage, and the site perimeter will be graded to prevent run-on. The area will be revegetated for erosion control, with a seed mix and/or vegetation consistent with the Seismic Retrofit Project biological assessment and subject to GGNRA review. Figure 7-3 presents the plan and a cross section of the backfill area.

7.5.2 EFFECT ON THE ENVIRONMENT OF THE SELECTED ALTERNATIVE

The selected alternative will result in clearing of the Phase I area, an activity which is necessary and will occur, regardless of lead concentrations, for the Seismic Retrofit Project. The net effect of the Lead Cleanup Project Phase I is to remove existing lead contamination from the site, to treat the lead to make it less available to the environment, and to encapsulate the lead as structured backfill in a planned excavation.

7.5.3 CONSISTENCY OF THE SELECTED OPTION WITH FEDERAL REGULATIONS

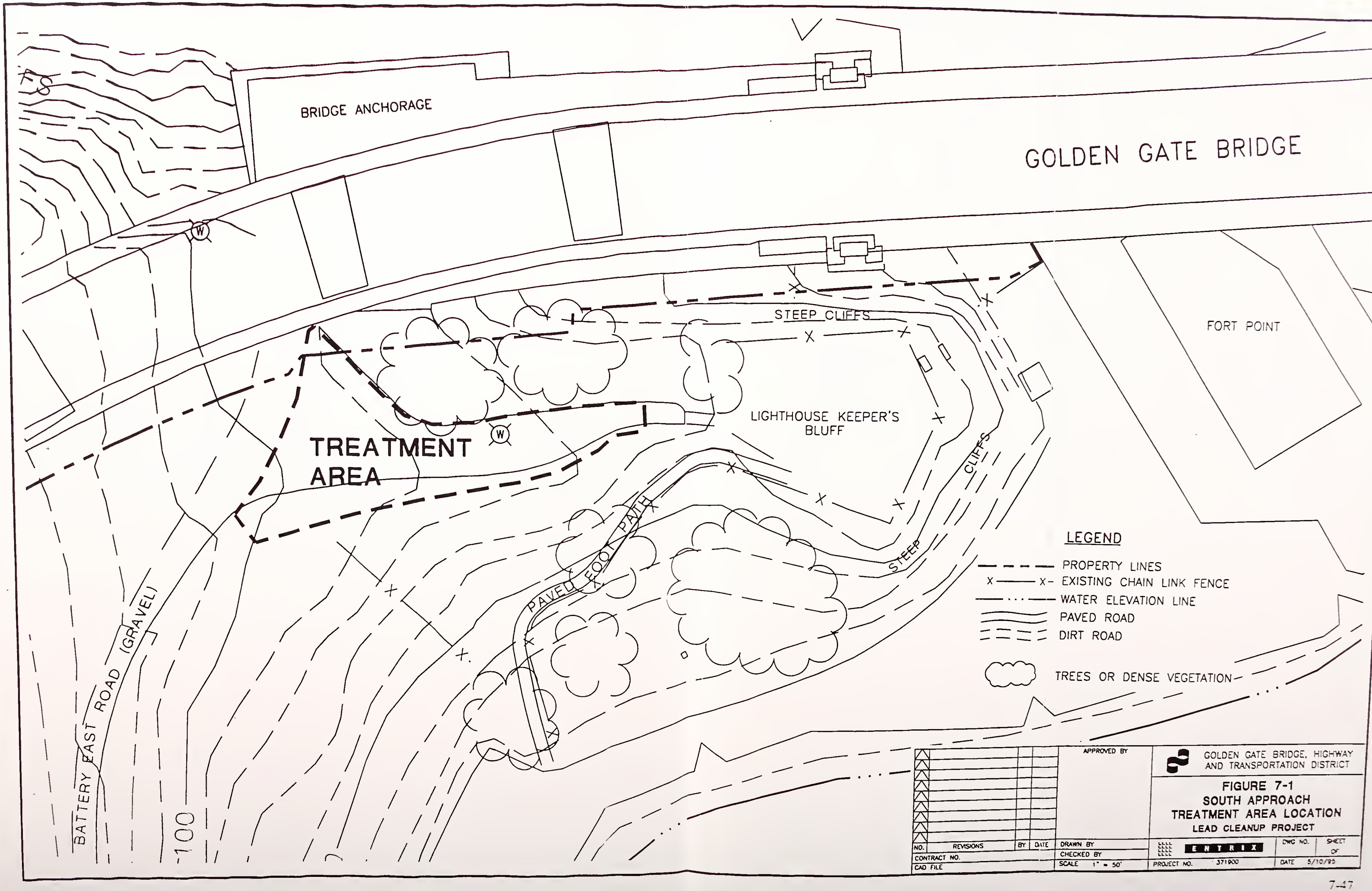
The selected option is consistent with CERCLA and National Contingency Plan (NCP) regulations. It is specifically consistent with federal emphasis on on-site treatment rather than off-site disposal.

7.5.4 OFF-SITE TRANSPORT OF HAZARDOUS WASTES

Soil and sand will be treated and left on-site in the Seismic Retrofit Project excavations. Hazardous waste transport off-site will be limited to gloves, Tyvek suits, and similar personnel protective equipment (PPE) used during remediation. Used PPE will be collected on site, in an appropriately labeled container. Containers will be considered a hazardous waste for disposal purposes. In the event of Seismic Retrofit Project developments that require expedited site preparation, or that eliminate the possibility of use of treated material as structured backfill, the off-site transport of contaminated material, as a hazardous waste, may be considered.

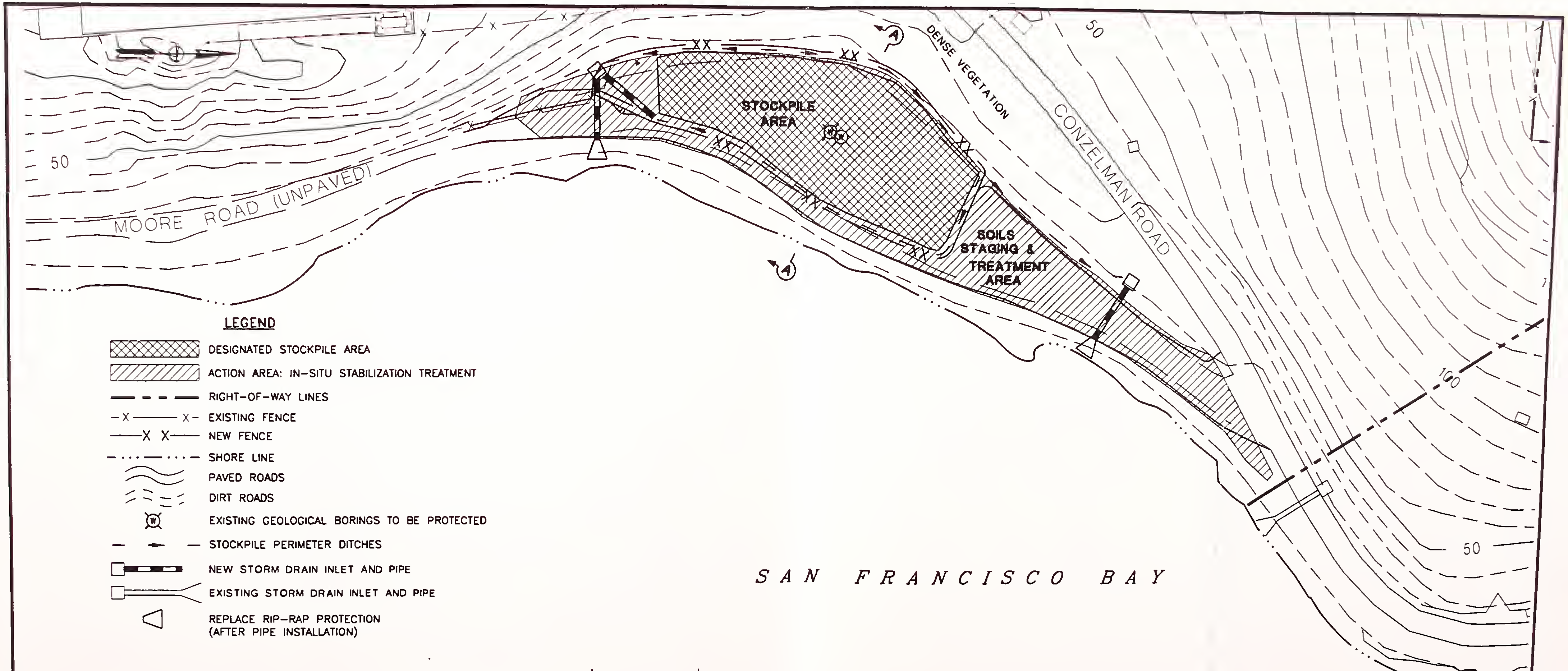
7.5.5 HEALTH AND SAFETY PLAN

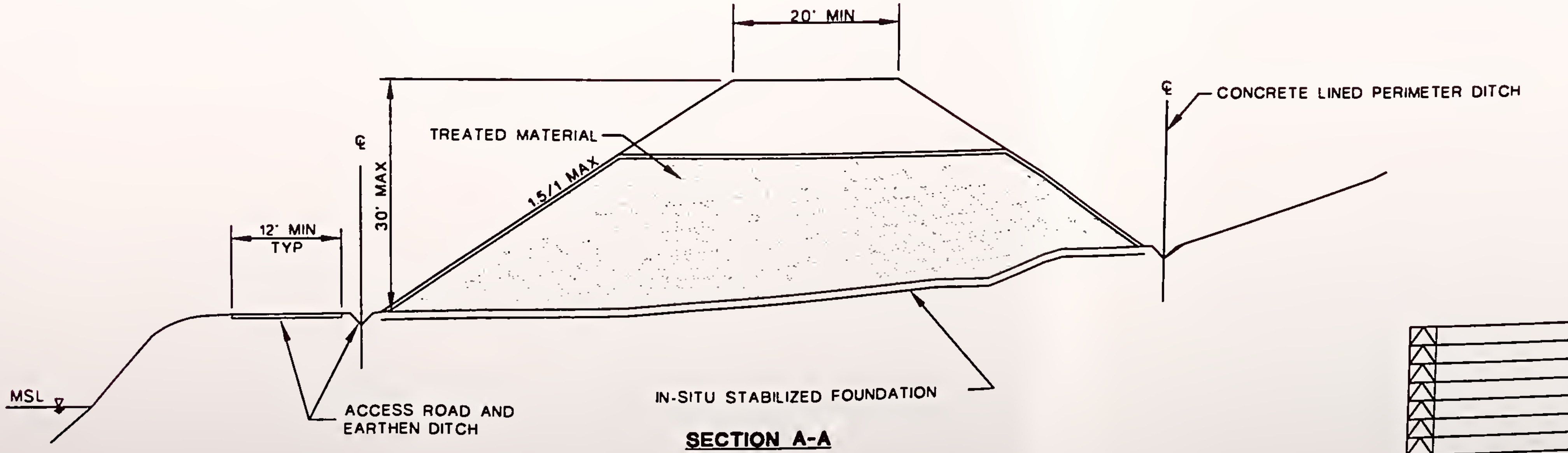
A site specific health and safety plan has been developed for previous site sampling activities for the Lead Removal Project (ENTRIX, June 1994). Contractors implementing the remedial action plan will be required to develop a health and safety plan for their workers that meets the minimum requirements of OSHA, Cal OSHA, and the existing site Health and Safety Plan.



GOLDEN GATE BRIDGE, HIGHWAY AND TRANSPORTATION DISTRICT

FIGURE 7-1
SOUTH APPROACH
TREATMENT AREA LOCATION
LEAD CLEANUP PROJECT


STOCKPILE AREA
SOILS STAGING & TREATMENT AREA
DENSE VEGETATION
CONZELMAN ROAD
MOORE ROAD (UNPAVED)
SAN FRANCISCO BAY
A
A
50
50
50
100
LEGEND
▩ DESIGNATED STOCKPILE AREA
▨ ACTION AREA: IN-SITU STABILIZATION TREATMENT
RIGHT-OF-WAY LINES
EXISTING FENCE
NEW FENCE
SHORE LINE
PAVED ROADS
DIRT ROADS
EXISTING GEOLOGICAL BORINGS TO BE PROTECTED
STOCKPILE PERIMETER DITCHES
NEW STORM DRAIN INLET AND PIPE
EXISTING STORM DRAIN INLET AND PIPE
REPLACE RIP-RAP PROTECTION (AFTER PIPE INSTALLATION)


20' MIN
TREATED MATERIAL
1.5/1 MAX
30' MAX
12' MIN TYP
MSL
CONCRETE LINED PERIMETER DITCH
ACCESS ROAD AND EARTHEN DITCH
IN-SITU STABILIZED FOUNDATION

SECTION A-A
NTS

NO.	REVISIONS	BY	DATE

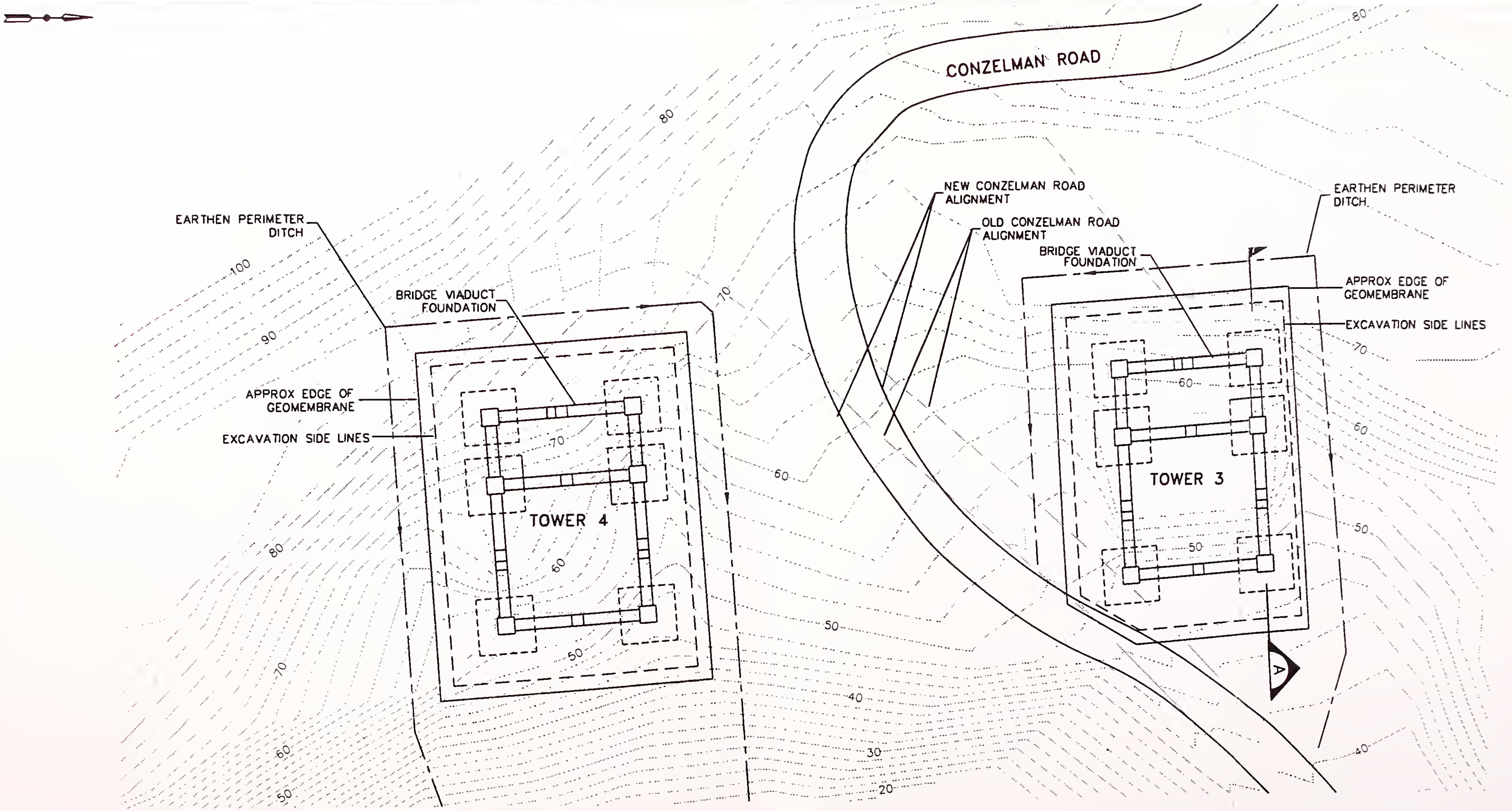
CONTRACT NO. N/A
CAD FILE GGBSPLOC.DWG

APPROVED BY
DATE
DRAWN BY DMG
CHECKED BY PMH
SCALE NTS

GOLDEN GATE BRIDGE, HIGHWAY AND TRANSPORTATION DISTRICT

FIGURE 7-2
NORTH APPROACH
PROPOSED STOCKPILE LOCATION
LEAD CLEANUP PROJECT

ENTRIX
DWG NO.
SHEET OF
PROJECT NO. 371902
DATE 9/7/95


CONZELMAN ROAD
EARTHEN PERIMETER DITCH
BRIDGE VIADUCT FOUNDATION
APPROX EDGE OF GEOMEMBRANE
EXCAVATION SIDE LINES
TOWER 4
NEW CONZELMAN ROAD ALIGNMENT
OLD CONZELMAN ROAD ALIGNMENT
BRIDGE VIADUCT FOUNDATION
EARTHEN PERIMETER DITCH
APPROX EDGE OF GEOMEMBRANE
EXCAVATION SIDE LINES
TOWER 3
A
100
90
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60
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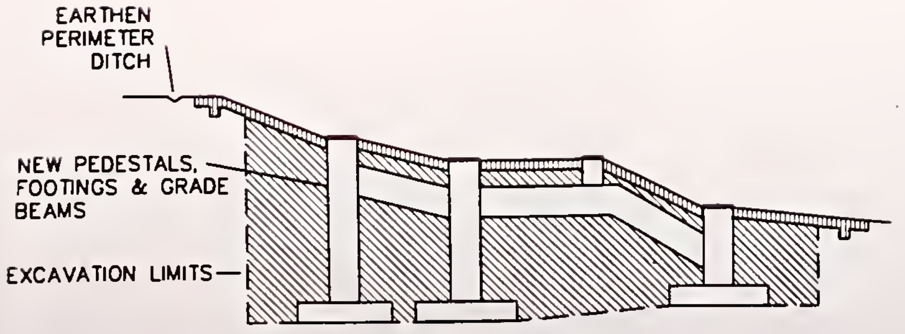
30
20



SECTION (A)
SCALE: 1" = 20'

LEGEND

- ▥ ENGINEERED CAP
- ▨ STABILIZED MATERIAL BACKFILL
- ☐ BRIDGE VIADUCT FOUNDATION

NO.	REVISIONS	BY	DATE

CONTRACT NO. 371902
CAD FILE RAP_7-3.DWG

APPROVED BY
DATE
DRAWN BY DMG
CHECKED BY PMH
SCALE NTS

GOLDEN GATE BRIDGE, HIGHWAY AND TRANSPORTATION DISTRICT

FIGURE 7-3
NORTH APPROACH
PROPOSED BACKFILL LOCATIONS
LEAD CLEANUP PROJECT

ENTRIX
DWG NO.
SHEET OF
PROJECT NO. N/A
DATE 9/7/95

General schedule considerations include the following:

- The construction start date in November 1995 depends on the GGBH&TD's obtaining federal funding for the Seismic Retrofit Project, of which this lead removal project is a part. Alternative methods of financing the Seismic Retrofit Project are also being investigated by the GGBH&TD.

- The construction start date in November 1995 depends on completion of remedial design (plans and specs), and a contract award, approval of Seismic Retrofit permits, and completion of the required CEQA review process.

- The stockpile site will be prepared first.

- Material from the south approach must be treated on-site, prior to transport to the north approach stockpile site, to pass EPA method 1311, TCLP requirements.

Specific tasks are expected to be completed at times indicated below:

- Submittal of Preliminary Draft RAP to DTSC - December 1994.

- Revised Draft RAP issued for formal review - May 1995.

- Final Draft RAP - September 1995.

- Public Review - occurs during the month of September 1995 (includes a public meeting in mid-September.

- Final RAP - October 1995.
- Final Remedial Design - October 1995.
- Contractor Mobilization - November 1995.
- Stockpile Site Preparation - begins in November 1995.
- South Approach Removal, Testing, and Transport to Stockpile occurs during December 1995 and January 1996.
- North Approach Removal, Testing, and Transport to Stockpile occurs during February and March 1996.

Transfer of the stockpile into the seismic retrofit project excavation will occur approximately two years later, after completion of Seismic Retrofit foundation work, with a duration of approximately 4 weeks.

9.0

OPERATION, MAINTENANCE AND MONITORING REQUIREMENTS

9.1 ONGOING OPERATION AND MAINTENANCE REQUIREMENTS

There is no specific ongoing soil or groundwater monitoring, only periodic sampling as part of site investigation programs. Implementation and maintenance of the Fence and Post Order, limiting access to the site, will continue through completion of the Lead Cleanup Project. Phase I will install additional fencing to keep seismic retrofit workers within the remediated Phase I areas.

After soil remediation, soil on-site will be below the human health based cleanup level. Material that is used as structured backfill will have been treated as necessary to limit solubility and availability for leaching. No specific long term monitoring is expected.

Air monitoring will be performed during remediation to provide worker protection and to limit dispersion of particulates and lead beyond the site.

Routine maintenance of culverts, "V" ditches, and junction boxes will be implemented to prevent blockage by sediment from erosion and run-off. Material collected by those maintenance activities will be tested for the presence of lead, and will be managed in accordance with hazardous waste regulations if appropriate.

Routine maintenance and inspection of the engineered cap over the structured backfill area will be performed to preserve the protective soil cover. Activities will include removal of deep rooting species of vegetation, identification and repair of cracks, and identification and repair of any erosion or wash out that may occur.

9.2 MEASURES TO PROVIDE FOR REMEDIATION OF CONTAMINATION DISCOVERED IN THE FUTURE

The Golden Gate Bridge, Highway, and Transportation District is committed to working with DTSC to fulfill state requirements, complete the Phase II site investigation, and implement necessary remedial actions. Contamination discovered outside the specific boundaries of Phase I will be addressed in Phase II of the Lead Cleanup Project.

Future recontamination of the area from sandblasting is unlikely because the current zinc silicate coating system can be maintained by re-application of a topcoat only. Ongoing blasting of all surfaces is not expected. Further, all use of lead based paint has been discontinued and the vast majority of lead based paint has previously been removed. Open sandblasting to remove lead based paint over the bridge approach areas has been completed.

Phase I is designed to remediate to levels consistent with the exposures of the Seismic Retrofit Project construction workers. At the completion of Phase I remediation the site will remain unavailable for public use. Access to Phase I areas will be limited to seismic retrofit workers, until completion of the Seismic Retrofit Project.

10.0

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California Environmental Quality Act (CEQA): A law mandating environmental impact review of governmental actions in California. The Act applies generally to all activities undertaken by state and local agencies, and to private activities financed, regulated, or approved by state and local agencies.

Draft Remedial Action Plan (RAP): A plan, approved by the DTSC, that outlines a specific program leading to the remediation of ta contaminated site. Once the Draft RAP is prepared, DTSC begins a public comment period that runs for a period of no less than 30 days. DTSC also holds a public meeting to take comments from the public. After the public comment has ended, and comments responded to in writing, DTSC approves the final remedy for the site (Final RAP).

Environmental Assessment/Initial Study (EA/IS): When a project is subject to CEQA and NEPA, an environmental assessment and initial study are conducted to assess potential environmental impacts including visual or noise impacts, impacts to culturalresources or historic structures, and impacts to threatened or endangered species. They also identify potential measures to mitigate or alleviate impacts.

Feasibility Study: A process to select sites requiring a remedy or mitigation, screen applicable technologies, develop remedial alternatives and perform detailed analysis and comparison of the alternatives.

Golden Gate Bridge Seismic and Wind Retrofit Project: Under a mandate from the Governor of the State of California, this project is designed to enhance the strength of the Golden Gate Bridge to withstand the maximum credible earthquake, with a nearby epicenter, occurring on the San Andreas or Hayward faults.

Health Risk Assessment (HRA): An evaluation of potential current and future risks to human health and the environment due to the presence of hazardous substances at the site.

Lead: A heavy metal that is present in small amounts throughout the human environment. Lead can enter the body from drinking contaminated water, eating vegetables grown in contaminated soil, or breathing contaminated dust when playing or working in contaminated areas. Lead can cause damage to the nervous system or blood cells if present in the body. Children are at highest risk from exposure to lead contamination because their bodies are still developing. Lead is listed as a reproductive toxic suubstance for women and men under Proposition 65.

mg/kg, mg lead/kg soil (milligram of lead per kilogram of soil): A unit of concentration equivalent to one part per million, in this case one part lead per million parts soil.

National Environmental Protection Act (NEPA): A federal law mandating environmental impact review of governmental actions. The Act applies generally to all activities undertaken by state and local agencies, and to private activities financed, regulated, or approved by state and local agencies.

Negative Declaration: CEQA document issued by the lead regulatory agency when the EA/IS reveals no substantial evidence that the proposed project will have a significant effect on the environment, or when any significant effects would be avoided or mitigated by revisions agreed to by the applicant.

Potentially Responsible Parties: An individual, company or government body identified as potentially liable for a release of hazardous substances to the environment. By federal law, such parties may include generators, transporters, storers and disposers of hazardous waste, as well as present and past site owners and operators.

Remedial Investigation (RI): A series of studies designed to identify the types and amounts of contamination present in the soil at a site.

Chemical Fixation: A soil remediation treatment technology using portland cement or comparable material as an additive to bind contaminants into an insoluble state.

APPENDIX A

STATEMENT OF REASONS

STATE OF CALIFORNIA — ENVIRONMENTAL PROTECTION AGENCY
PETE WILSON, *Governor*

DEPARTMENT OF TOXIC SUBSTANCES CONTROL
REGION 2
700 HEINZ AVE., SUITE 200
BERKELEY, CA 94710-2737

STATEMENT OF REASONS

Pursuant to California Health and Safety Code (HSC) section 25356.1(e), the California Environmental Protection Agency, Department of Toxic Substances Control (DTSC) has prepared this Statement of Reasons as part of the Remedial Action Plan for the Phase I Removal Action planned at the Golden Gate Bridge Site.

The RAP summarizes the findings of site characterization results to date, the results of the health risk assessment, and the evaluations of feasible remedial alternatives conducted to date. The proposed removal action will meet the objectives of protecting public health and the environment. A fence and post order was issued on July 15, 1992 and the publicly-accessible portions of the Site remain fenced. The removal action proposed for the Phase I portion of this project consists of vacuum removal of sand and soil, vegetation removal, demolition of structures, heavy equipment removal of sand and soil, erosion and drainage control, verification testing, equipment decontamination, and the treatment, stockpiling and backfilling of the sand and soil.

DTSC believes that the attached RAP complies with the law as specified in HSC section 25356.1. HSC section 25356.1(e) requires that RAPs "shall include a statement of reasons setting forth the basis for the removal and remedial actions selected." The statement of reasons "shall also include an evaluation of the consistency of the removal and remedial actions proposed by the plan with the federal regulations and factors specified in subdivision (d)....". Subdivision (d) specifies six factors against which the remedial alternatives in the RAP must be evaluated. The proposed remedial action is consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (the National Contingency Plan, NCP), the federal Superfund regulations. the attached RAP has addressed all of these factors in detail. A brief summary of each factor follows. The statement of reasons also includes the preliminary Nonbinding Allocation of Responsibility (NBAR) as required by HSC section 25356.1(e).

1. Health and Safety Risks -- Section 25356.1(d)(1)

The identified chemical of concern in the Phase I area is lead in soils. Zinc is likely also present in some Site soils.

The Health Risk Assessment evaluated potential exposures for tourists, joggers, bicyclists, children at play, fishermen on shore, commuters, surfers, boaters, bridge maintenance workers, construction workers and Golden Gate Recreation Area groundskeepers. Of these, seismic retrofit workers were found to have the greatest potential for exposure. The Health Risk Assessment determined that an appropriate lead cleanup level for protection of human health under current and probable future land use scenarios is 1396 milligram of lead/kilogram.

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STATE OF CALIFORNIA — ENVIRONMENTAL PROTECTION AGENCY
PETE WILSON, *Governor*

DEPARTMENT OF TOXIC SUBSTANCES CONTROL
REGION 2
700 HEINZ AVE., SUITE 200
BERKELEY, CA 94710-2737

PRELIMINARY NONBINDING ALLOCATION OF RESPONSIBILITY

Health and Safety Code (HSC) Section 25356.1(d) requires the Department of Toxic Substances Control (DTSC) to prepare a preliminary nonbinding allocation of responsibility (the "NBAR") among all identifiable potentially responsible parties (PRPs). HSC section 25356.3(a) allows PRPs with an aggregate allocation in excess of 50% to convene an arbitration proceeding by submitting to binding arbitration before an arbitration panel. If PRPs with over 50% of the allocation convene arbitration, then any other PRP wishing to do so may also submit to binding arbitration.

The sole purpose of the NBAR is to establish which PRPs will have an aggregate allocation in excess of 50% and can therefore convene arbitration if they so choose. The NBAR, which is based on the evidence available to DTSC, is not binding on anyone, including PRPs, DTSC, or the arbitration panel. If a panel is convened, its proceedings are de novo and do not constitute a review of the provisional allocation. The arbitration panel's allocation will be based on the panel's application of the criteria spelled out in HSC section 25356.3(c) to the evidence produced at the arbitration hearing. Once arbitration is convened, or waived, the NBAR has no further effect, in arbitration, litigation or any other proceeding, except that both the NBAR and the arbitration panel's allocation are admissible in a court of law, pursuant to HSC section 25356.7 for the sole purpose of showing the good faith of the parties who have discharged the arbitration panel's decision.

For the Golden Gate Bridge Site: The Golden Gate Bridge, Highway and Transportation District (GGBHTD) is the current operator at the site, the U.S. Army is the prior owner of the Site, and the United States Department of the Interior is the current owner of the Site. This Draft RAP covers Phase I of the remedial activities at the Golden Gate Bridge Site and is necessary for and a part of the GGBHTD's Seismic Retrofit Project. The foregoing parties have agreed that the preliminary NBAR may designate that GGBHTD will be 100% responsible for the implementation of the activities covered in this Draft and Final RAP. This designation is without prejudice to GGBHTD's right to challenge such allocation in any subsequent proceedings, except the right to seek binding arbitration pursuant to HSC section 25356.3(a) which right is expressly waived. The parties have further agreed that each party reserves its rights to seek recovery of its costs against any party whether currently identified as a PRP or otherwise. Consistent with the agreement of the parties, the DTSC's preliminary NBAR allocates 100% of the responsibility for activities covered by the Draft and Final Phase I RAP to GGBHTD.

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Sandblasting activities associated with zinc paint were limited to portions of the south approach. The site remedial investigation did not specifically characterize the extent of zinc in the sand and soil at the Site. However, the extent of the zinc-impacted sands and soil should be within the area impacted by lead. As lead has a higher toxicity and lead-impacted area is much greater, lead was used as an indicator chemical. The proposed remedial action incorporates testing of the sand and soil for zinc.

2. Beneficial Uses of the Site Resources - Section 25356.1(d)(2)

Groundwater beneath the Site is not being used. The Regional Water Quality Control Board (RWQCB) may classify the groundwater found under certain parts of the Site as potentially suitable for domestic water supply. However, the lead contamination appears to be limited to the near surface soils and sands. Therefore, we do not anticipate having impacted groundwater.

Portions of the Phase I area are used for recreational purposes. During construction activities, limited trail and road closures will be necessary to protect visitors from construction hazards. Regular use of Fort Point and visitor parking will also be reduced. The Environmental Assessment/Initial Study outlines mitigation measures which will be incorporated into this project, if approved. Some of the Site is currently fenced, posted, and inaccessible to the public. Following site preparation and implementation of the Phase I area remedial action plan, hiking and bicycle paths in the Golden Gate National Recreation Area which have been closed due to soil lead contamination will be reopened for visitor use at the conclusion of the Seismic Retrofit construction.

3. Effect of the Remedial Actions on Groundwater Resources - Section 25356.1(d)(3)

Geotechnical work completed for the seismic retrofit project included borings in the vicinity of the towers under the viaduct section of the north approach. Data from these borings indicate the presence of a confined aquifer approximately 42 feet below ground surface at Tower No. 3 near Conzelman Road. The lead contamination in the Phase I area appears to be limited to the near surface soils and sands. Therefore, we do not anticipate having impacted groundwater. Groundwater beneath the Site is not being used, although RWQCB may classify the groundwater found under certain parts of the Site as potentially suitable for domestic water supply.

4. Site-Specific Characteristics -- Section 25356.1(d)(4)

Chemicals in the Phase I area soil have been adequately characterized. The proposed removal action would remove lead-affected soils above cleanup goals from the Phase I area and immobilize it, prior to using the soils as backfill material. This will allow additional portions of the Site to be publicly accessible once the seismic retrofit work is completed. Chemicals have the potential to migrate offsite through surface water runoff to the San Francisco Bay. The project incorporates plans for erosion and drainage controls. These are outlined in the Environmental Assessment/Initial Study.

5. Cost Effectiveness of Alternative Remedial Actions -- Section 25356.1(d)(5)

The proposed remedial alternative was the most cost-effective alternative to implement, except for the "no action" alternative. However, the "no action" alternative would not be expected to meet the cleanup objectives.

6. Potential Environmental Impacts of Remedial Action - Section 25356.1(d)(6)

All potential environmental impacts of this project will be mitigated under the proposed remedial alternative. The proposed alternative will not create any significant environmental impacts. A Draft Environmental Assessment/Initial Study has been prepared for the project by the Golden Gate Bridge, Highway and Transportation District (GGBHTD), the U.S. Department of Transportation Federal Highway Administration (FHWA), and the California Department of Transportation (Caltrans) in cooperation with the National Park Service (NPS) and the Golden Gate National Recreation Area (GGNRA). Because of this, the GGBHTD proposes to adopt a Negative Declaration pursuant to the California Environmental Quality Act (CEQA) for the recommended removal action alternative. An Environmental Study Checklist was completed for the Site which discussed potential environmental impacts of the recommended remedial alternative, as well as actions that will be taken to reduce or eliminate these potential environmental impacts during implementation. The Draft Environmental Assessment/Initial Study, CEQA Environmental Study Checklist and proposed Negative Declaration are being distributed under separate cover for a thirty day public comment period concurrent with the public comment period for the draft RAP.

7. Preliminary Nonbinding Allocation of Financial Responsibility - Section 25356.1(e)

The RAP must include a "nonbinding preliminary allocation of responsibility among all identifiable potentially responsible parties at a particular site, including those parties which may have been released, or may otherwise be immune, from liability..." (HSC, Section 25356.1(e)). The current NBAR for the Site, as issued by DTSC, is presented on the next page.

APPENDIX B

RESPONSIVENESS SUMMARY
(RESERVED)

APPENDIX C

ADMINISTRATIVE RECORD LIST

ADMINISTRATIVE RECORD LIST
FOR THE GOLDEN GATE BRIDGE SEISMIC RETROFIT PROJECT, PHASE 1 LEAD CLEANUP AND SITE PREPARATION

California Health and Safety Code Section 25256.1

National Contingency Plan (40 CFR. 300.61 et seq.)

DTSC's Official Policy and Procedure No. 87-2, Remedial Action Plan Development and Approval Process, October 5, 1987.

U.S. Environmental Protection Agency, Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final, EPA/540/G-89/004, October 1988.

Preliminary Survey of Lead in Surface Soils at the North and South Approaches of the Golden Gate Bridge.
Date: 5/26/92

Fence and Post Order
Date: 7/15/92

Interim Report on Lead in Surface Soils, GGNRA, June 1992
Date: June 1992, received July 21, 1992

Letter from Kary Witt of GGBHTD to Barbara Cook of DTSC
Date: 9/1/92
Subject: Fence & Post Order compliance, PEA request

Letter from Barbara Cook of DTSC to J. Juan Alcedo of US Army
Date: 9/15/92
Subject: Fence & Post Order inspection, PEA fees

Letter from Kary Witt of GGBHTD to Barbara Cook of DTSC
Date: 10/20/92
Subject: Fence & Post Order compliance

Letter from Kary Witt of GGBHTD to Barbara Cook of DTSC
Date 10/20/92
Subject: Summary of agreements made in meeting on 10/19/92 in re: general cleanup plans

Press Release
Date: 9/24/93
Subject: Announcement that GGBHTD awarded contract to ENTRIX.

Letter from Kary Witt of GGBHTD to Annina Antonio of DTSC
Date: 9/27/93
Subject: Notice that GGBHTD awarded contract to ENTRIX to perform the Site Investigation, Risk Assessment, and RAP planning.

Work Plan: Golden Gate Bridge Lead Contamination Cleanup Project
Date: 11/16/93

Report: Pilot Test Results
Date: 11/18/93
Subject: Vacuum Truck Demonstration

Report: Field Demonstration
Date: 12/8/93
Subject: Demonstration of lead detection equipment using X-ray fluorescence.

Letter from Kary Witt of GGBHTD to Annina Antonio of DTSC
Date: 2/14/94
Subject: Summary of agreements made in meeting on 1/20/94 in re: general cleanup plans

Letter from Kary Witt of GGBHTD to Nancy Hornor of NPS
Date: 2/15/94
Subject: Summary of agreements made in meeting on 2/15/04 in re: general cleanup plans

Letter from Kary Witt of GGBHTD to Stuart Simms of US Army
Date: 3/4/94
Subject: Summary of agreements made in meeting on 2/24/94 in re: general cleanup plans

Letter from Peter Hendricks of ENTRIX to Annina Antonio
Date: 4/5/94
Subject: Implementation of sampling

Letter from Brian O'Neill of NPS to Carney Campion of GGBHTD
Date: 4/8/94
Subject: Comments on proposed structure (Phase 1/2) of project

Letter from Peter Hendricks of ENTRIX to Annina Antonio
Date: 4/19/94
Subject: Revised cleanup approach

Letter from Jose Ballesteros of US Army to Merv Giacomini
Date: 4/11/94
Subject: Water line through contaminated area

Report: Results of Preliminary Vertical Delineation
Date: 5/16/94
Subject: Shows sand depth and lead concentration at depth

Letter from Brian O'Neill of NPS to Carney Campion of GGBHTD
Date: 5/18/94
Subject: Comments on 5/2/94 Removal Action Plan

Letter from Kary Witt of GGBHTD to Brian O'Neill of NPS
Date: 6/1/94
Subject: Response to 5/18/94 comments on May 1, 1994 Removal Action Plan

Letter from Norman Ozaki, SOMA, to Annina Antonio, DTSC
Date: June 2, 1994
Subject: Lead Risk Assessment Spreadsheet Version 1.0

Letter from Annina Antonio of DTSC to Kary Witt of GGBHTD
Date: 6/22/94
Subject: Comments on 5/2/94 Removal Action Work Plan

Letter from Kary Witt of GGBHTD to Barbara Cook of DTSC
Date: 6/23/94
Subject: Confirmation of two-phased approach

Letter from Brian O'Neill of NPS to Kary Witt of GGBHTD
Date: 7/1/94
Subject: Clarification of comments made on 5/18/94 in re: 5/2/94 Removal Action Plan

Report: Phase II Draft Work Plan for Site Characterization
Date: 7/8/94

Letter from Martha Walters of NPS to Jim Carlisle of DTSC
Date: 7/14/94
Subject: Information on worker exposure

Letter from Brian O'Neill of NPS to Carney Campion of GGBHTD
Date: 8/5/94
Subject: Comments on Phase II Site Characterization Work Plan dated 7/15/94 and on Phase I Preliminary Draft RAP dated 7/15/94

Letter from Martha Walters of NPS to Annina Antonio of DTSC
Date: 8/19/94
Subject: Water line and fiber optic cable installation in project areas

Memorandum from James Carlisle, DTSC, to Annina Antonio, DTSC
Date: 8/25/94
Subject: Risk Assessment for Golden Gate National Recreation Area (GGNRA)

Letter from Kary H. Witt of GGBHTD to Brian O'Neill of NPS
Date: 9/22/94
Subject: Response to the National Park Service's August 5, 1994 letter commenting on the Phase II Site Characterization Work Plan and the Phase I Preliminary Draft RAP.

Letter from Kary Witt of GGBHTD to Annina Antonio of DTSC
Date: 9/27/94
Subject: Submittal of Draft Community Profile and Mailing List

Letter from Brian O'Neill of NPS to Carney Campion of GGBHTD
Date: 11/3/94
Subject: Clarification of 8/5/94 comments on Phase II Site Characterization Work Plan dated 7/15/94 and on Phase I Preliminary Draft RAP dated 7/15/94

Letter from Carol Northrup of DTSC to Mary Currie of GGBHTD
Date: 11/15/94
Subject: Comments on Community Profile

Letter from Ben Hargrove/Frank Gaunce, DTSC, to Kary Witt, GGBHTD
Date: May 2, 1995
Subject: Comments on the Preliminary Draft Remedial Action Plan Golden Gate Bridge Seismic Retrofit Project, Phase I Lead Cleanup and Site Preparation

Letter from Carol Northrup of DTSC to Mary Currie of GGBHTD
Date: June 9, 1995
Subject: Revised Golden Gate Bridge Draft RAP Fact Sheet and Public Noticing

DTSC: Department of Toxic Substances Control
GGBHTD: Golden Gate Bridge Highway and Transportation District
NPS: National Park Service